

WATER-CHEMISTRY AND CHLORIDE FLUCTUATIONS IN THE UPPER FLORIDAN AQUIFER IN THE PORT ROYAL SOUND AREA, SOUTH CAROLINA, 1917-93

by James E. Landmeyer and Donna L. Belval

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BRUCE BABBITT, *Secretary*

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Gordon P. Eaton, *Director*



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For additional information write to:

District Chief
U.S. Geological Survey
Stephenson Center-Suite 129
720 Gracern Road
Columbia, SC 29210-7651

Copies of this report can be purchased
from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225-0286

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CONVERSION FACTORS AND ABBREVIATIONS

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
inch (in.)	25.40	millimeter
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot squared per day (ft ² /d)	0.09290	meter squared per day
gallon (gal)	3.785	liter
gallon per minute (gal/min)	0.06308	liter per second
mile (mi)	1.609	kilometer
million gallons per day (Mgal/d)	3785	cubic meter per day
million gallons per year (Mgal/yr)	1.38 x 10 ⁶	cubic meter per year

Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [(ft³/d)/ft²]ft. In this report, the mathematically reduced form, foot squared per day (ft²/d), is used for convenience.

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F} = 1.8 (^{\circ}\text{C}) + 32$$

Specific electrical conductance of water is expressed in microsiemens per centimeter at 25 °C (μS/cm). This unit is equivalent to micromhos per centimeter at 25 °C.

Below sea level is abbreviated as “bsl” throughout the report.

Chemical concentration in water is expressed in milligrams per liter (mg/L) or micrograms per liter (μg/L).

Density of a fluid is expressed as mass per unit volume (g/m³).

Sea level: In this report “sea level” refers to National Geodetic Vertical Datum of 1929 - a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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CONVERSION FACTORS AND ABBREVIATIONS--Continued

Other abbreviations used in this report:

BFT - Beaufort County
BRK - Berkeley County
BRN - Barnwell County
DIC - dissolved inorganic carbon
DOR - Dorchester County
HAM - Hampton County
JAS - Jasper County
SCDHEC - South Carolina Department of Health and Environmental Control
SCDNR-WRD - South Carolina Department of Natural Resources - Water Resources
Division
SCWRC - South Carolina Water Resources Commission
TDS - total dissolved solids
T.U. - tritium units
UPZ - upper permeable zone
USEPA - United States Environmental Protection Agency
WATSTORE - National Water Data Storage and Retrieval System

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ABSTRACT

Withdrawal of water from the Upper Floridan aquifer south of Port Royal Sound in Beaufort and Jasper Counties, South Carolina, has lowered water levels and reversed the hydraulic gradient beneath Hilton Head Island, South Carolina. Ground water that had previously discharged at the Sound is now being deflected southwest, toward withdrawals located near the city of Savannah, Georgia, and the island of Hilton Head. The reversal of this hydraulic gradient and the decline of water levels have caused saltwater in the Upper Floridan aquifer north of Port Royal Sound to begin moving southwest, toward water-supply wells for the town of Hilton Head and toward industries pumping ground water near Savannah.

Analytical results from ground-water samples collected from wells in the Upper Floridan aquifer beneath and adjacent to Port Royal Sound show two plumes in the aquifer with chloride concentrations above the drinking-water standard. One plume of high chloride concentration extends slightly south of the theoretical predevelopment location of the steady-state freshwater-saltwater interface as indicated by numerical modeling. The other plume is present beneath the town of Port Royal, where the upper confining unit above the Upper Floridan aquifer is thin or absent. In these areas, the decline in water levels caused by ground-water withdrawals may have made it possible for water from tidal creeks to enter the Upper Floridan aquifer.

Many wells completed in the upper permeable zone of the Upper Floridan aquifer show a distinct specific-conductance profile. One non-producing, monitoring well on Hilton Head Island (BFT-1810) was selected to depict a worst-case scenario to examine the short- and long-term water-chemistry and chloride fluctuations in the aquifer. Specific conductance was monitored at depths of 170, 190, and 200 feet below the top of the well casing. The specific conductance measured in 1987 ranged from approximately 450 microsiemens per centimeter near the top of the Upper Floridan aquifer to 1,500 microsiemens per centimeter near the lower, less permeable zone. Short-term fluctuations in conductance were measured at each probe and were found to be related to water-level fluctuations in the well caused by tidal cycles. The conductance varied regularly up to 100 microsiemens per centimeter, with an increasing time lag between high and low tides and low and high specific conductance for progressively shallower depths.

Well BFT-1810 was monitored for specific conductance and water levels from October 1987 through September 1993. Specific conductance at the 170-foot probe showed little long-term change, while the 190- and the 200-foot probes showed long-term increases to approximately 4,000 and 10,000 microsiemens per centimeter, respectively. This well is located closest to one of the two plumes of saltwater delineated in the Upper Floridan aquifer, and the long-term chloride increases are a result of the movement of saltwater in the Upper Floridan aquifer toward Hilton Head Island under the influence of regional ground-water withdrawals.

INTRODUCTION

The Upper Floridan aquifer produces water of excellent quality (low dissolved-solids concentration) throughout most of Beaufort and Jasper Counties, S.C. The towns of Hilton Head and Bluffton in Beaufort County, for example, rely solely on this aquifer as a source of water supply (fig. 1). Additionally, approximately 100 Mgal/d of high-quality water are withdrawn from the Floridan aquifer system in the vicinity of the city of Savannah, Ga., 25 mi southwest of Port Royal Sound (Garza and Krause, 1992). The main reason that the aquifer has produced such high-quality water can be explained by the hydrology of the system. The approximate predevelopment potentiometric surface of the Upper Floridan aquifer, as documented by Warren (1944), indicated that regional ground-water flow of freshwater was seaward toward Port Royal Sound, and ground water discharged into the Sound under artesian pressure. Because of this steady-state seaward hydraulic gradient, freshwater heads in the area surrounding western Port Royal Sound and farther to the west in Georgia, were higher than sea level, thereby preventing any appreciable landward movement of the freshwater-saltwater interface and consequent degradation of the quality of water.

Since withdrawals centered in Savannah from the Upper Floridan aquifer began about 1880, a cone of depression developed in Savannah and the zero-foot contour (freshwater head equal to saltwater head) has migrated northward into Beaufort and Jasper Counties. The resultant reversal of ground-water-flow direction has increased the potential for water-quality deterioration by saltwater encroachment. Additionally, the development of Hilton Head Island as a resort community during the past 25 years has led to an increased demand on the aquifer as a source of public water supply and for tourist-related industries such as golf. The water use on Hilton Head Island also has contributed to the lower heads beneath the island, as part of the cone of depression centered near Savannah. The cone of depression and head declines have reversed the predevelopment hydraulic gradient of the potentiometric surface in the aquifer from one of seaward (toward Port Royal Sound) to southwestward (from Port Royal Sound).

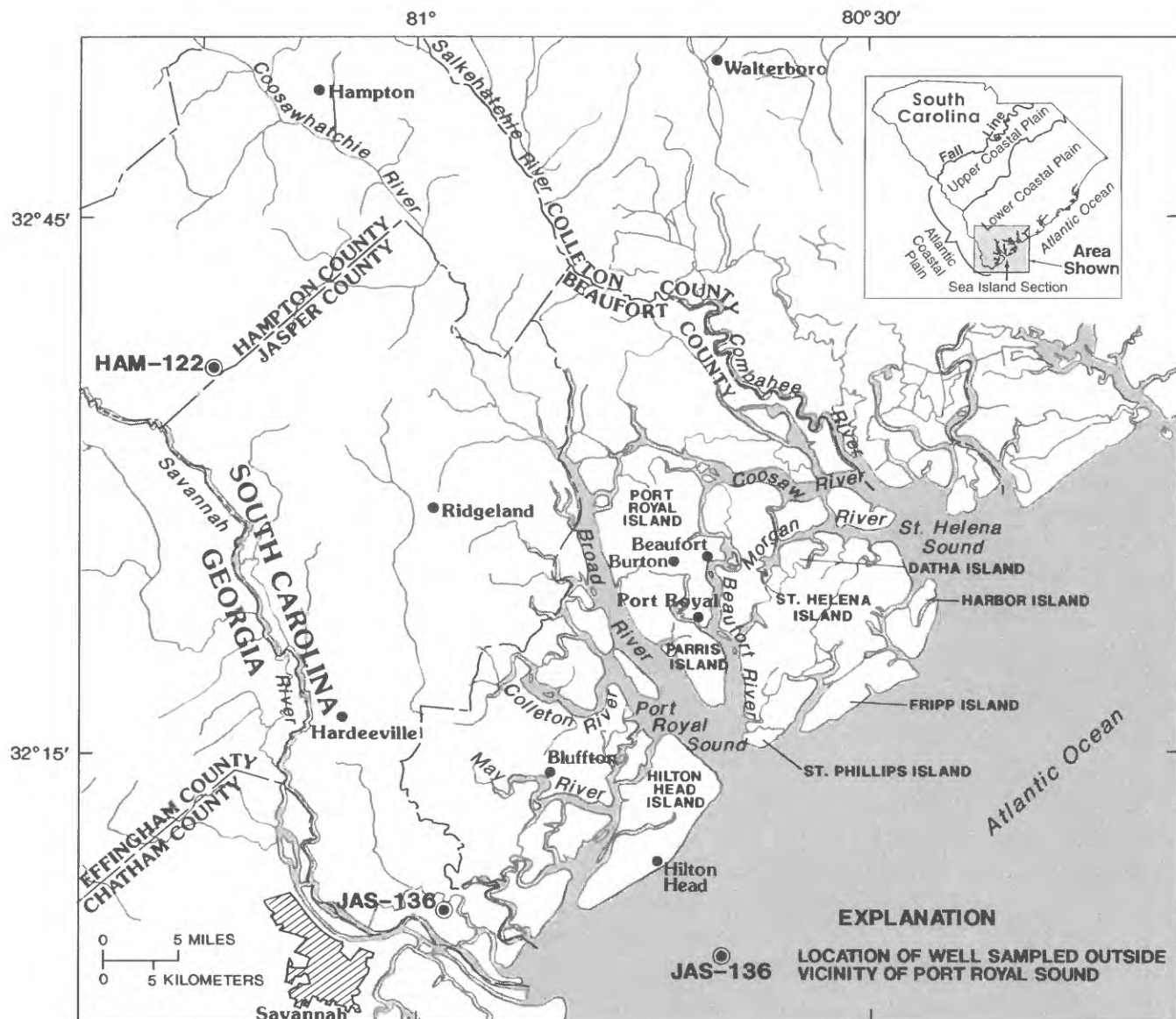


Figure 1. Study area and location of wells sampled outside the Port Royal Sound area, S.C.

Since the 1940's, the presence of naturally occurring, hydraulically expected chloride in ground water has been documented in the upper permeable zone (UPZ) of the Upper Floridan aquifer in parts of Beaufort and Jasper Counties (Warren, 1944; Counts and Donsky, 1963; Siple, 1965; Hayes, 1979). In 1984, the U.S. Geological Survey (USGS), in cooperation with the South Carolina Department of Natural Resources-Water Resources Division (SCDNR-WRD), then the S.C. Water Resources Commission [SCWRC], initiated a study of the water chemistry and hydrogeologic characteristics of the Upper Floridan aquifer in the area of Port Royal Sound. The study was designed to investigate the geologic, hydrologic, and geochemical characteristics, and the occurrence of chloride in the Upper Floridan aquifer in the Port Royal Sound area, and to assess saltwater encroachment into the aquifer.

Purpose and Scope

This report provides an overview of the water-chemistry trends and chloride location and fluctuations in the UPZ of the Upper Floridan aquifer in the Port Royal Sound area. The overview presents information: (1) to document trends and changes in water chemistry and chloride concentrations that have occurred as a result of withdrawal-induced saltwater encroachment, (2) to assess the effects of tidally induced chloride fluctuations in the UPZ of the Upper Floridan aquifer, and (3) provide a historical database for future studies. The report provides historical and recent ground-water chemistry data for the aquifer beneath Port Royal Sound and adjacent areas, and offers possible mechanisms to describe saltwater encroachment into the aquifer in some parts of the study area. Short- and long-term fluctuations of chloride concentration in a continuously monitored observation well on the north end of Hilton Head Island nearest to the naturally occurring seawater in the aquifer are documented for 1987 to 1993.

Drinking-Water Standards

Water withdrawn from the Upper Floridan aquifer beneath the Port Royal Sound area requires minimal treatment to meet national drinking-water standards for potable water (U.S. Environmental Protection Agency, 1994). To estimate the extent of saltwater encroachment and the mixing with freshwater, several constituents indicative of such water-chemistry degradation are examined in this report and are compared to the State's water-chemistry standards. These constituents include concentrations of chloride and total dissolved solids (TDS), and other major anions and cations such as dissolved iron and dissolved manganese. The water-chemistry standards for public supply set by the South Carolina Department of Health and Environmental Control (SCDHEC) are essentially those set by the U.S. Environmental Protection Agency (USEPA), and are presented in table 1 for the constituents and properties considered in this study. The Primary Drinking Water Standards refer to those concentrations of constituents in potable ground water that are considered to be potential health hazards. The Secondary Drinking Water Standards refer to concentrations of constituents for which a maximum allowable level in drinking water has been set.

Table 1.--*Selected South Carolina water-quality standards for constituents in drinking water, 1994*

[mg/L, milligrams per liter]

Constituent	Maximum contaminant level ^a (mg/L)
Arsenic	0.05
Barium	2
Cadmium	.005
Chloride	250
Chromium	0.1
Cyanide	.2
Fluoride	4
Iron	0.3
Lead	0.015
Manganese	0.05
Mercury	.002
Nitrate (as Nitrogen)	10
Selenium	.05
Total dissolved solids	500

a. U.S. Environmental Protection Agency, 1994

The concentration of chloride and measurement of specific conductance in ground-water samples from the study area show a direct relation (fig. 2). Therefore, the specific conductance of a water sample can be used indirectly to estimate the chloride concentration for those samples where chloride analyses are not available. In this report, chloride concentration and specific conductance were used to determine the extent of the saltwater encroachment in the aquifer until 1989; specific conductance only was used from 1989 to 1993.

To quantify the extent of saltwater encroachment into the aquifer, the concentration of the chloride ion $[Cl^-]$, and indirectly, the specific conductance is used for the following reasons:

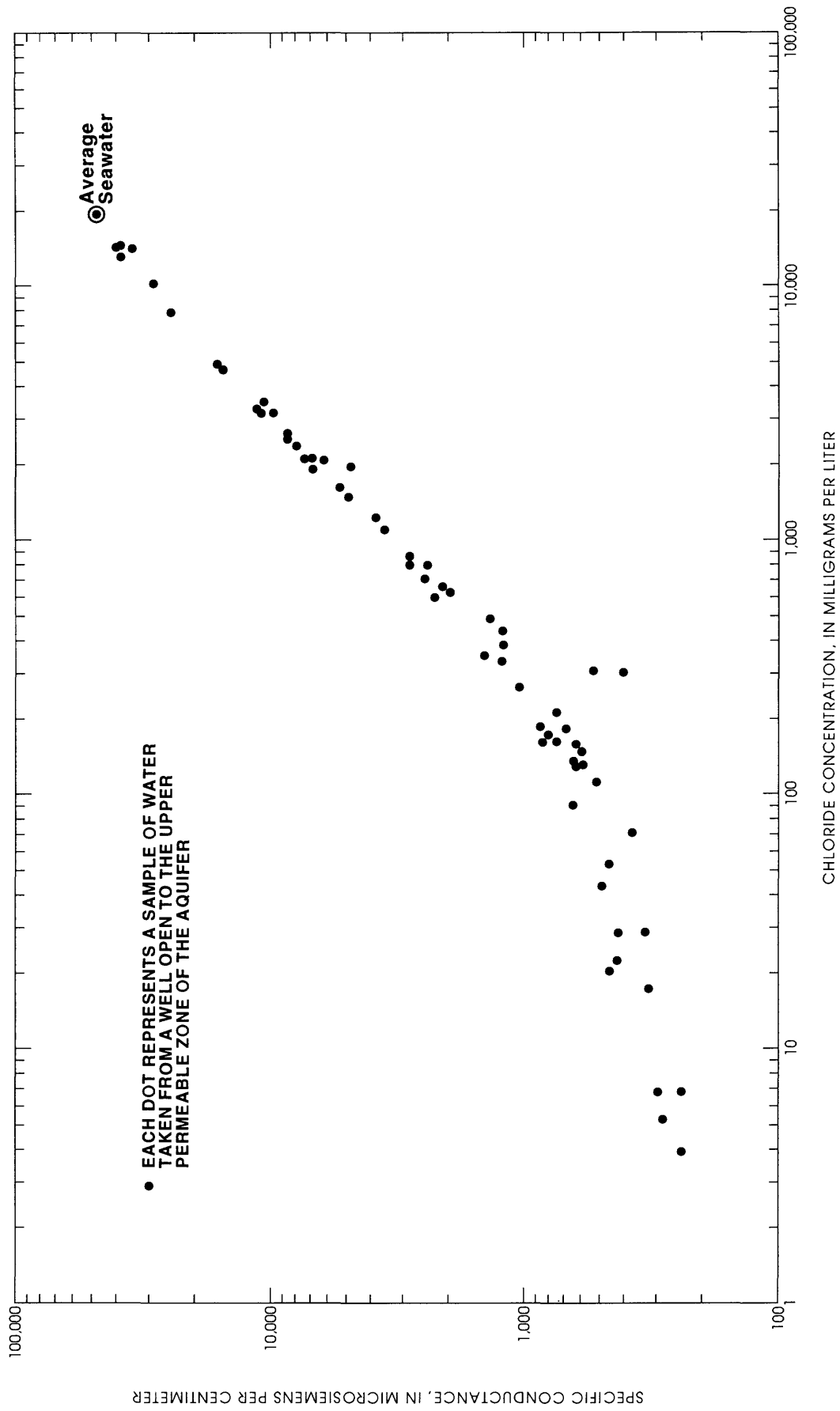
1. Chloride is the ion in highest concentration in seawater (about 19,000 mg/L). In ground water not affected by seawater, the chloride concentration is about 10 mg/L or less. Water-quality degradation is indicated in a freshwater aquifer by chloride concentrations greater than 50 to 100 mg/L.
2. Chloride is a conservative constituent in ground water; it has a low reactivity with the geologic material of the aquifer and it does not react appreciably with other dissolved constituents present in ground water (Kaufman and Orlob, 1956).
3. The analysis to determine the concentration of chloride ion (or indirectly, the specific conductance) is one of the least involved and most reproducible procedures in water-chemistry analysis (Hem, 1985).

At concentrations greater than 250 mg/L, the chloride-ion complex (such as sodium chloride in seawater) renders such potable water salty to some people. Most people notice a salty taste at concentrations greater than 400 mg/L (Hem, 1985).

Well-Numbering System

Wells used in this study are identified by an alpha-numeric county well number, such as BFT-1810. The alpha characters represent the county in which the well is located, such as BFT for Beaufort. The numerical part of the well identifier is a number corresponding to the order in which either the well was drilled or recorded. BFT-12, therefore, was either the 12th well drilled or recorded in Beaufort County.

This well identification system was not in use when the initial studies were done in the study area in the early 1900's. Wells referenced then were simply identified by a description or relative location. With time, many of these non-unique landmarks have changed, and some of the wells mentioned in those early studies cannot be relocated.



Previous Investigations

Reports by several investigators provide background information for comparison to the results from this study. Saltwater encroachment in the Upper Floridan aquifer in Beaufort County was documented as early as 1944 by Warren, and subsequent studies have attempted to precisely describe the geology of the aquifer system as well as the extent of saltwater encroachment. Specifically, other companion reports published in conjunction with this present study include a numerical-flow model of the Upper Floridan aquifer by Smith (1988), the geochemical diagenesis within the Upper Floridan aquifer by Burt (1993), a compilation of data from wells drilled in Port Royal Sound by Burt and others (1987), and a report of saltwater contamination in the aquifer (Hughes and others, 1989). Also in conjunction with the study, a density-dependent ground-water-flow and transport model to simulate movement of the freshwater-saltwater interface in the Port Royal Sound area has been developed (Smith, 1993). Other published reports pertaining to the ground-water resources and geology of the locality are Back and others (1970), Callahan (1964), Colquhoun and others (1969), Comer (1973), Cooke (1936), Cooke and MacNeil (1952), Counts (1958, 1960), Counts and Donsky (1963), Crouch and others (1987), Duncan (1972), Hassen (1985), Hayes (1979), Landmeyer (1992), Landmeyer and Stone (1995), McCollum and Counts (1964), Mundorff (1944), Siple (1946, 1956, 1960, 1965, 1967, 1969), Stone and others (1986), Stringfield (1966), and Warren (1944).

Acknowledgments

The design and implementation of the 5-year study and the offshore drilling operations can be accredited to Bill Lichtler, formerly of the USGS, and Camille Ransom, III of the SCDHEC. Michael Crouch and W. Brian Hughes, formerly of the SCDNR-WRD, collected and analyzed much of the geologic and hydrologic information for the study. Water-chemistry data presented in the report were collected with the guidance and help of Ron Burt, formerly of the USGS.

DESCRIPTION OF STUDY AREA

The study area includes Beaufort and Jasper Counties, the southernmost counties on the South Carolina coast, and is within the Sea Islands section of the Atlantic Coastal Plain physiographic province (fig. 1). The Sea Islands section includes a series of low-lying barrier islands interspersed with saltmarshes and separated by saltwater tidal creeks and rivers. The generally flat mainland has widely dispersed low hills and expanses of freshwater marsh. Land surfaces in the two counties commonly range from 10- to 30-ft above sea level, reaching a maximum elevation of about 90 ft in the northwestern part of the area. The dominant physical feature of the area is Port Royal Sound, an estuary approximately 3 mi across at its confluence with the ocean, 4 mi across at its widest point, and extending 24 mi inland.

The Coosawhatchie River, which originates in the Coastal Plain, is called the Broad River as it widens near the coast, and is the major river that empties into Port Royal Sound. Tidal amplitudes range from an average of 8 ft at the mouth of the Sound to an average of 7 ft in the mainland upper reaches. Spring tidal amplitudes as much as 10.3 ft have been documented (South Carolina Water Resources Commission, 1972). Other waterways in the area include the Beaufort, Colleton, Combahee, Coosaw, May, and Morgan Rivers.

The towns in Beaufort and Jasper Counties, such as Beaufort, Port Royal, Hardeeville, Ridgeland, and Bluffton, were well established by the early nineteenth century. The establishment of an U.S. Marine Corps Base at Parris Island about 1900 resulted in fluctuations in the population of nearby Port Royal and Beaufort, depending on the scope of military mobilization. The greatest increase in population of the area, however, has occurred during the past 20 years. During this time, several of the Sea Islands, such as Datha, Harbor, Fripp, and especially Hilton Head Island, have been developed as resort communities. Hilton Head Island had a resident population of 20,823 in 1992, compared to 2,456 in 1970. Growth projections for Beaufort County estimate a 39-percent increase in population between 1985 and 2000 (McCready, 1989), which would make it the third-fastest growing county in South Carolina.

HYDROGEOLOGY

The Atlantic Coastal Plain Province in South Carolina and adjacent states is underlain by a wedge-shaped sequence of sediments that thicken from a feather edge at the Fall Line (fig. 1), approximately mid-state, to about 4,000 ft in Jasper County near the study area. These sediments include the clastic and marine Late Cretaceous-age Cape Fear, Middendorf, and Black Creek Formations; Tertiary-age units comprising the clastic Congaree, McBean, and Barnwell Formations, their downdip marine equivalents, the Santee and Ocala Limestones, and the overlying clastic Hawthorn Formation; and Quaternary-age coastal terrace deposits such as the Pamlico, Talbot, and Waccamaw Formations (Aucott and Speiran, 1985; Hughes and others, 1989).

Most of these formations become thinner and shallower farther northeast along the Atlantic Coast and some, including the Santee and Ocala, are not present along the northeast coast of South Carolina. This regional thinning of the formations is a result of the Cape Fear Arch, a Late Eocene basement high centered near Cape Fear, N.C. (Cooke, 1936; Siple, 1946). A section of the shallow sediments in the Coastal Plain of southeastern South Carolina is shown in figure 3. The general hydrologic, geologic, and lithologic units of these sediments as given by Smith (1988) are shown in figure 4.

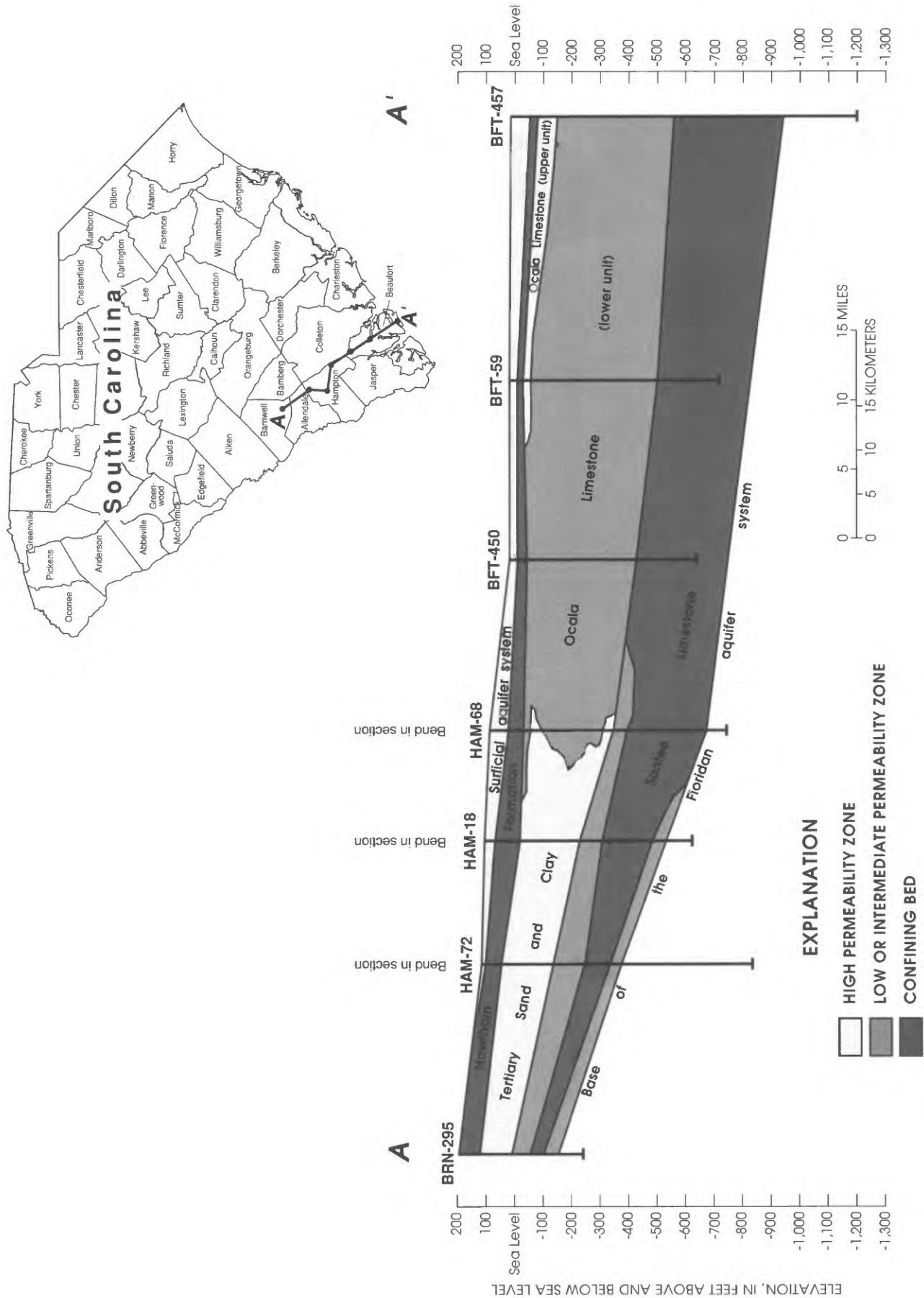


Figure 3. Generalized hydrogeologic section A-A', indicating major aquifers and confining units beneath the study area (modified from Crouch and others, 1987).

AGE	REGIONAL AQUIFER SYSTEM		LOCAL HYDRO-GEOLOGY	LITHOLOGY	FORMATION		
HOLOCENE	SURFICIAL AQUIFER SYSTEM			SAND, MARL, SHELL, SILT, AND CLAY	UNDIFFERENTIATED		
PLEISTOCENE					TALBOT AND PAMLICO FORMATION		
PLIOCENE					WACCAMAW FORMATION		
MIOCENE	UPPER CONFINING UNIT			FINE SAND, SILT, CLAYEY SAND, SANDY CLAY, CLAY, PHOSPHATIC PEBBLES, AND SANDY LIMESTONE	HAWTHORN FORMATION		
OLIGOCENE				SANDY MARL, AND LIMESTONE		UNDIFFERENTIATED	
LATE EOCENE	FLORIDAN AQUIFER SYSTEM	UPPER FLORIDAN AQUIFER SYSTEM	UPPER PERMEABLE ZONE	HIGHLY PERMEABLE, POROUS, BIOCLASTIC LIMESTONE	OCALA LIMESTONE	UPPER UNIT	
			LOCAL CONFINING UNIT	CLAYEY, FOSSILIFEROUS LIMESTONE OF LOW PERMEABILITY		LOWER UNIT	
MIDDLE EOCENE		MIDDLE CONFINING UNIT			SANDY LIMESTONE AND FINE SAND OF LOW PERMEABILITY		SANTEE LIMESTONE
		LOWER FLORIDAN AQUIFER			LOWER PERMEABLE ZONE		

Figure 4. Generalized hydrologic, geologic, and lithologic units of the Floridan aquifer system in South Carolina and southeastern Georgia (from Smith, 1988).

The Santee Limestone of middle Eocene age lies beneath Hilton Head Island between 500 and 1,000 ft below land surface and has been described as a massive calcarenitic limestone having very low permeability (Hughes and others, 1989). The Santee is overlain by the upper and lower units of the Ocala Limestone of late Eocene age. The lower unit is a silty, clayey, glauconitic limestone of low permeability between depths of 300 and 350 ft (Hughes and others, 1989). The upper unit of the Ocala Limestone is a clean, permeable, bioclastic limestone, and is the major source of ground water in the study area. This unit will be referred to in this report as the UPZ. It is about 20-ft below sea level (bsl) near the Combahee River to 200-ft bsl near the Savannah River. It lies about 100- to 200-ft bsl at Hilton Head Island. This unit ranges in thickness from less than 10 ft along the Combahee River near where it pinches out to approximately 180-ft-thick near the Savannah River to the south. Beneath Hilton Head Island, the Ocala Limestone is about 100-ft thick. The top 6 to 12 in. of the Ocala Limestone commonly consists of a hard, phosphatic layer of indurated limestone, known locally as a "cap rock." Updip of the study area, the marine Ocala undergoes a facies change to clastic rock that crops out in Barnwell, Allendale, Aiken, and Edgefield Counties in South Carolina (fig. 3) and in several counties across Georgia (Miller, 1986).

The Ocala Limestone is overlain by undifferentiated Oligocene sediments and the Miocene-age Hawthorn Formation, an olive-gray, phosphatic clayey sand. The Hawthorn Formation ranges in thickness from 10 ft to about 70 ft, and occurs between 20- and 130-ft bsl in the study area. The Hawthorn acts as an upper confining unit for the Upper Floridan aquifer. In some parts of the study area where the Hawthorn Formation may have been breached during lower stands of sea level in the Pleistocene age, the relatively thin formation provides a hydraulic connection between the overlying surficial aquifer system and the underlying Ocala Limestone. Updip of Port Royal Sound in northern Jasper County, the Hawthorn Formation contains considerably more sandy strata, which locally are tapped by low yield (<20 gal/min) wells. The Hawthorn Formation is overlain by other Miocene sediments north of the study area and by Pliocene to Holocene sand and clay immediately in the study area.

A structural high, designated the "Burton High" by Siple (1969), is centered near the towns of Beaufort and Burton (fig. 1). In this area, both the upper units of the Ocala Limestone and the Hawthorn Formation reflect the effects of that structural high, because the units become thinner and are closer to land surface. In the area between Beaufort and the Combahee River, the Hawthorn Formation is only about 10-ft thick, and its top is less than 20-ft bsl. The upper permeable unit of the Ocala Limestone is 20-ft thick or less in this area as it pinches out, and its upper surface is less than 40-ft bsl.

Miller (1986) described the Floridan aquifer system as the major Coastal Plain aquifer system in eastern Alabama, Georgia, Florida, and southern South Carolina. This aquifer has been known in the past as the Tertiary limestone aquifer and, particularly in South Carolina, the principal artesian aquifer. Miller defined this system as generally consisting of two aquifers, an Upper Floridan aquifer and a Lower Floridan aquifer, separated by a less permeable middle unit. This definition is based primarily on permeability characteristics and less on stratigraphy. Each aquifer may, therefore,

contain several lithostratigraphic units. In the study area, however, the boundaries of the Upper Floridan aquifer generally coincide with the top and bottom of the Ocala Formation.

South of the study area near Savannah, the Upper Floridan aquifer contains five permeable zones used as potable water sources by the city of Savannah. The Floridan aquifer system is considerably thicker there, because all Coastal Plain sediments thicken and become deeper in that direction. Borehole flowmeter tests made by McCollum and Counts (1964) indicated that more than 70 percent of the water withdrawn from wells came from the upper two of these five zones. Additionally, these two upper zones become less discrete farther to the north, so that only a single zone is identifiable beneath Hilton Head Island and Port Royal Sound. This single UPZ is the one described previously as the Oligocene bioclastic zone at the top of the Ocala Limestone, and in which most of the production wells in Beaufort and Jasper Counties are located. The lower three permeable zones identified in Savannah probably are missing in the study area in South Carolina.

In Beaufort and Jasper Counties, wells drilled deeper than the UPZ are not common. Hughes and others (1989) reported that only a single well on Hilton Head Island is known to produce water from lower units and showed chloride concentrations of approximately 600 mg/L. In contrast, most pumped wells completed in the UPZ beneath Hilton Head Island produce water having chloride concentrations below 100 mg/L.

Hydraulic characteristics of the Upper Floridan aquifer have been estimated from aquifer tests made in the UPZ. The hydraulic conductivity ranges from about 350 to 450 ft/d, except beneath Port Royal Island, where it ranges from about 50 to 150 ft/d. The storage coefficient ranges from 5.5×10^{-5} beneath Port Royal Island to 4.0×10^{-4} in other areas. Transmissivity ranges from less than 500 ft²/d beneath northern Port Royal Island to 70,000 ft²/d beneath Hilton Head Island. The greater transmissivity beneath Hilton Head primarily is due to the larger thickness of the limestone beneath Hilton Head Island (Hughes and others, 1989).

The primary stratigraphic (outcrop or subcrop) and historical (predevelopment) recharge area for the Upper Floridan aquifer is updip of the study area. The recharge area is in the clastic outcrop that extends from Allendale, Barnwell, Aiken, and Edgefield Counties in South Carolina into Georgia (Miller, 1986).

The general direction of ground-water flow in what is now called the Upper Floridan aquifer in the study area was first documented by Warren (1944), as part of a study investigating the artesian conditions of the Georgia Coastal Plain. Warren presents a map of the estimated predevelopment potentiometric surface (about 1880) as determined from data collected and reported by McCallie (1898; 1908) and Stephenson and Veatch (1915); and a map of the potentiometric surface for 1942. These potentiometric surface maps indicate that the ground-water-flow lines in the area of Port Royal Sound from about 1880 until 1942, converged at the Sound; therefore, water in the

Upper Floridan aquifer discharged into the Sound and surrounding bays as evidenced by the presence of submarine springs (Counts and Donsky, 1963). For example, the name of the bay between Hilton Head Island and the mainland, Calibogue, is derived from the Indian word meaning "deep spring". This suggests that a seaward ground-water-flow system has been observed since at least the 1400's. Warren (1944) mapped a decline in water level in wells at Savannah ranging from 90 to 100 ft between about 1880 and 1942.

By 1958, the zero-foot, or sea-level contour of the potentiometric surface, had been laterally displaced northeast from the Savannah area to beneath Hilton Head Island. This displacement indicated that the ground-water-flow path in the highly transmissive limestone in the middle of Hilton Head Island was now southwest toward Savannah, rather than eastward and convergent on Port Royal Sound (Siple, 1960; Counts, 1960). Maps of potentiometric surface by Mundorff (1944) and Hayes (1979) also showed local cones of depression in the Beaufort area.

The development of Hilton Head Island as a resort area began in the late 1960's, and pumped wells in the Upper Floridan aquifer on the island presented an additional stress on the aquifer. The map of the potentiometric surface by Hayes (1979) showed the zero-foot contour to the north of Hilton Head Island, and the map of the potentiometric surface of the Upper Floridan aquifer in 1986 by Crouch and others (1987) showed the zero-foot contour to be in the middle of Port Royal Sound. The present (1996) ground-water-flow direction beneath all of Hilton Head Island, therefore, is toward the southwest, away from the Sound and toward pumping centers in Savannah.

Some studies have shown that localized recharge is occurring to the Upper Floridan aquifer from the surficial aquifer system at Hilton Head Island in areas where ground water had previously discharged under predevelopment conditions (Siple, 1965; Back and others, 1970; Stone and others, 1986). The potential exists for downward leakage of water from overlying sediments to infiltrate through the underlying Hawthorn Formation to the Upper Floridan aquifer, because the head in the Floridan aquifer is below sea level, and the water level in the surficial aquifer system is at or above sea level. Radiocarbon concentration indicative of modern water in the Upper Floridan aquifer near Port Royal Sound has been measured (Back and others, 1970; Stone and others, 1986).

This potential for induced recharge is especially significant where the Hawthorn Formation is thin and, in some places absent, beneath some of the tidal creeks that contain brackish or salty water. When the zero-foot contour of the potentiometric surface was south of the area where the Hawthorn Formation thins, the aquifer discharged freshwater through breaches in the confining unit (as submarine seeps or springs) to surface-water bodies in response to the vertical upward-head gradient. However, when the zero-foot contour of the potentiometric surface shifted to the north of these breached areas, the vertical-head gradient was reversed. Where the head of the saltier surface water is higher than the freshwater head in the aquifer, the potential exists for saltwater to enter the aquifer.

WATER CHEMISTRY IN THE UPPER FLORIDAN AQUIFER

The water chemistry of the Upper Floridan aquifer has undergone changes since samples were first collected and recorded in the early 1900's. Most of these changes, such as in areas of increased salinity, probably resulted from ground-water withdrawal. Because of this relation between water chemistry and water use, the following section describes water-chemistry changes in ground water from the Upper Floridan aquifer with time, and documents how water-use trends have affected water quality.

Historical Water Chemistry

Problems associated with the quality of water obtained from the UPZ were first documented at Parris Island, S.C. Typically, wells initially would yield water of good quality, but the water would eventually become too salty for use. Burnette (1952) reported that two of the three supply wells drilled in 1899 were abandoned by 1903 because of the high salt content of the pumped water.

After World War I, eight wells drilled in 1919 along the railroad in Port Royal supplied water to Parris Island. Water from these wells had chloride concentrations that ranged from 16 to 226 mg/L (T.L. Burnette, unpub. data). These wells were abandoned in 1930 because of bacterial contamination, possibly by the entrance of *Escherichia coli* through the annular space of the wells.

In the late 1920's, several wells were drilled at Jericho Point, adjacent to Parris Island (fig. 5). Although water from these wells also had high chloride concentrations, they remained the primary source of water for residents of Parris Island until the Burton well field (fig. 5) began supplying water in December 1942. By March 1944, the Burton wells supplied approximately 42 Mgal/yr and the Jericho Point wells about 13 Mgal/yr to Parris Island (Mundorff, 1944). The two major wells at the Burton well field produced ground water that had a stable chloride concentration of 12 mg/L.

Problems with the quality of the water from the wells in the town of Beaufort began in the early 1940's (Hayes, 1979). In 1941, water use in Beaufort began to increase markedly, possibly because of an increase in the military service population. By 1944, the main supply well in downtown Beaufort was supplying about 0.25 Mgal/d, and the chloride concentration, which had previously ranged from 30 to 40 mg/L, reached 190 mg/L in November 1943. The well was taken out of service in 1946. Subsequent aquifer tests by Hazen and Sawyer (1956) yielded water having a chloride concentration of 44 mg/L in 1955.

By 1960, Siple reported that Beaufort was supplied ground water by eight wells that pumped between 100 to 130 gal/min. Each well was alternately shut off for one day to allow for partial recovery of the water level. The estimated consumption at that time was 0.48 to 0.75 Mgal/d at Beaufort and 0.06 Mgal/d at Port Royal.

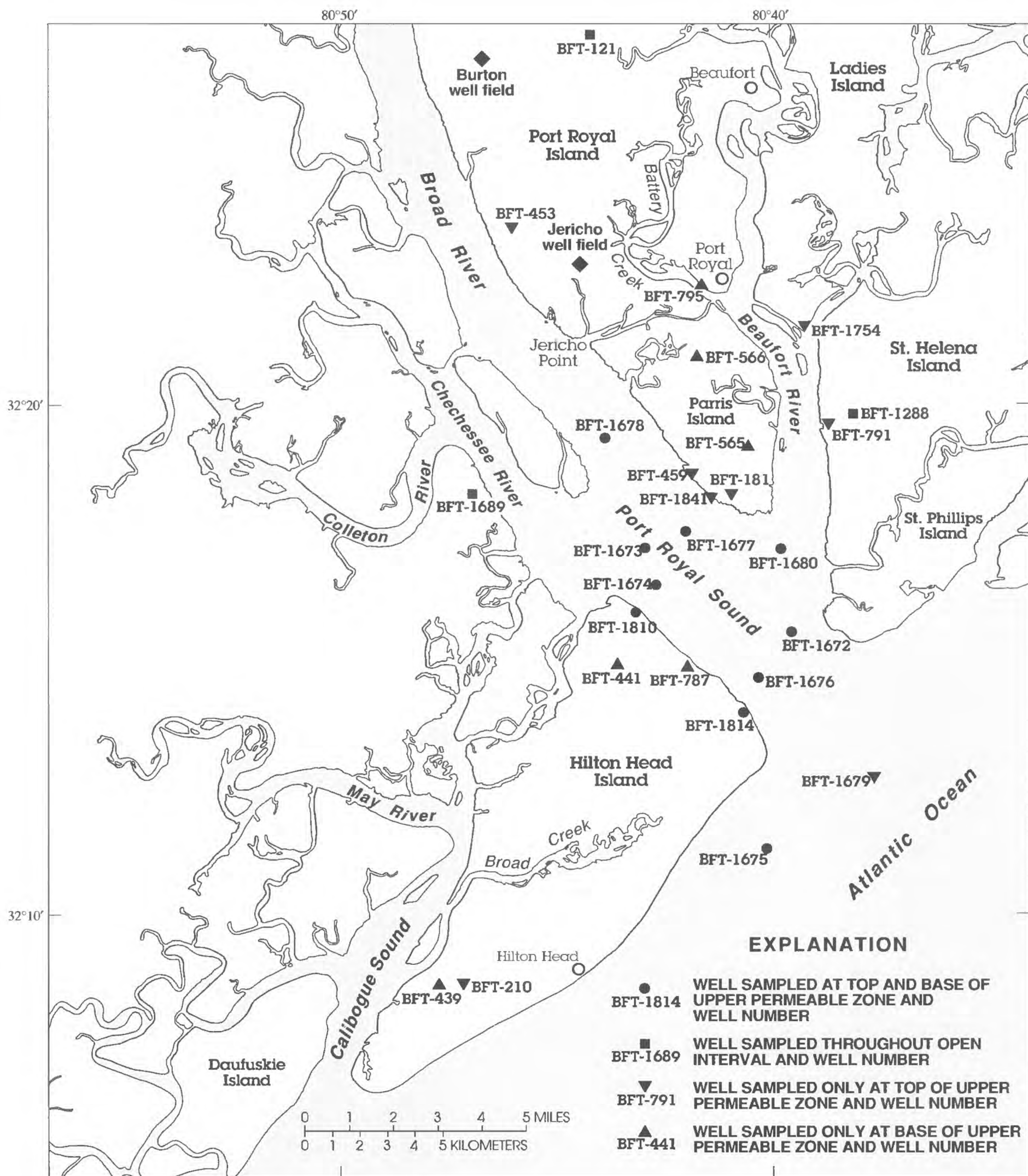


Figure 5. Locations of wells sampled in the Port Royal Sound area, S.C.

The towns of Beaufort and Port Royal resorted to surface water in 1965. Surface water from the Savannah River was supplied by a canal to the Beaufort-Jasper County Water and Sewer Authority plant, that currently (1996) supplies water to the towns of Beaufort and Port Royal, Ladies Island, the Marine Corps Air Station, and the Parris Island Marine Base.

Some areas do not use the Beaufort-Jasper County Water and Sewer Authority as a source of their supply, but still use wells constructed into the UPZ of the Upper Floridan aquifer. The Upper Floridan aquifer is used extensively by farmers on St. Helena Island for irrigation, although the concentration of chloride becomes too high as the potentiometric surface declines. A study of ground-water conditions in the Ladies and St. Helena Islands area (fig. 5) by Hassen (1985) reported that chloride concentrations in water from the Upper Floridan aquifer ranged from 7 to 13,200 mg/L, the higher values being present in aquifer discharge areas near tidal creeks and the ocean, and the lower values in areas of inland ground-water recharge and higher freshwater head.

To document changes in the water chemistry of the Upper Floridan aquifer with time, water-chemistry results completed by previous researchers have been compiled (tables 2, 3, and 4). These analyses have been taken from reports referenced herein specific to the study area. Well names and numbers given are as they appear in each report. The results are presented in order of date published.

The results from previous reports were selected to include only those that pertain to the UPZ of the Upper Floridan aquifer when possible. There are some factors, however, that may preclude direct comparisons of concentrations of a particular constituent taken at the same location at different times:

1. Some wells may be open to the UPZ of the Upper Floridan aquifer and the Hawthorn Formation, which, in some areas, is used as an aquifer and produces water having a ground-water chemistry different from that obtained from the UPZ of the Upper Floridan aquifer. In these cases, the results from these wells are a composite of both aquifers.
2. Some wells may be drilled into the UPZ and the lower, less permeable zone that contains water having a higher concentration of chloride; these results represent a composite of both water sources.
3. Sampling methods were not always documented, and they may differ. Methods known to have been used include point sampling from a depth of 10 to 25 ft, point sampling near the bottom of the casing, point sampling at the middle of the open hole, and sampling from the spigot of a pumped well after pumping. Each of these methods may produce samples that may yield different results from the same well on the same sampling date.

4. Some wells are not fully grouted. Accordingly, these wells are more susceptible to contamination from water in formations above or below the zone of interest, and from surficial sources.

Present-Day Water Chemistry

A comprehensive study was begun in 1984 to determine the water chemistry of the UPZ of the Upper Floridan aquifer in the Port Royal Sound area (Burt and others, 1987). This study included (1) drilling temporary observation wells into the UPZ beneath the Sound to obtain water-chemistry data in areas of the aquifer that previously had never been sampled, (2) sampling existing wells on the mainland that represent the UPZ, and (3) drilling sampling wells on the mainland at selected sites adjacent to Port Royal Sound where data were previously unavailable.

Methods

To obtain data on the water chemistry from the UPZ of the Upper Floridan aquifer beneath Port Royal Sound, nine wells were drilled using a self-elevating platform ship (the Sea Horse) operated by the U.S. Army Corps of Engineers. The Sea Horse is a barge that converts to a drilling platform by lowering three leg-like supports to the bottom, and hydraulically lifting the platform above the water surface. The nine wells were drilled between July 17 and October 6, 1984, and are identified as wells BFT-1672 through BFT-1680 (fig. 5). Water-chemistry and geologic samples, and hydrologic and geophysical data were collected. Burt and others (1987) summarized these data and the methods used in collecting them, including the grouting techniques used during well installation. Selected water-chemistry results from these Port Royal Sound wells are documented in table 5 and listed by ascending well number.

Seventeen existing wells, and three new onshore wells (BFT-1810, BFT-1814, and BFT-1841) drilled onshore into the UPZ of the Upper Floridan were sampled. Geophysical logs were used to verify that wells used for sampling tapped only the Upper Floridan aquifer. Analyses from these wells are included in table 5.

The freshwater-saltwater interface in the UPZ was delineated in three dimensions by sampling water at either the top of the aquifer using wells drilled approximately 10 to 20 ft into the Upper Floridan aquifer, or by sampling at the base of the UPZ within 10 ft of the lower, less permeable part of the aquifer. Wells drilled into the UPZ generally were sampled at the top and base of the aquifer. Exceptions were BFT-1679 and BFT-1841, which were sampled only at the interval near the top of the aquifer.

Wells were sampled using the method of withdrawing three well volumes using a submersible pump, then measuring specific conductance, temperature, dissolved-oxygen concentration, and pH until nearly constant measurements were observed. Two pumps were used to sample the wells. A high-capacity centrifugal pump was used to produce an upward flow in wells open to the base of the UPZ of the Upper Floridan aquifer. A submersible pump was then used to sample water below the centrifugal pump at the interval of interest. This procedure was used to ensure that the water sample was representative of the ground water from the sampled interval in the aquifer.

Water samples were analyzed by the USGS National Water Quality Laboratory in Arvada, Colo., and by the SCDNR-WRD laboratory in Columbia, S.C. Some constituents not analyzed by the SCDNR-WRD were measured by the USGS laboratories, including nitrate, ammonia, dissolved phosphorus, orthophosphate, dissolved organic carbon, and most of the trace elements. Sulfide concentration was determined by the SCDNR-WRD laboratory by using a sulfide-ion electrode method (ORION Research, Inc., Model 94-16).

Samples were processed, preserved, and analyzed for chemical constituents using established procedures (Skougstad and others, 1979). Values of temperature, specific conductance, and concentrations of dissolved oxygen, alkalinity, bicarbonate, and carbonate were obtained in the field using techniques described by Wood (1976). The USGS laboratory followed an incremental titration procedure (Barnes, 1964) to determine alkalinity. The SCDNR-WRD laboratory used a fixed-endpoint (pH of 4.5) titration method. The concentration of dissolved solids was obtained by using 103 °C as the drying temperature by the SCDNR-WRD laboratory, and 180 °C by the USGS laboratories. Although the methods used were different, Hem (1985) states that the different drying temperatures do not produce significantly different results for most of the more dilute natural waters compared to other factors that may influence this determination.

Water samples for deuterium (^2H), oxygen-18 (^{18}O), tritium (^3H), stable carbon isotopes ($\delta^{13}\text{C}$), and carbon-14 (^{14}C) were collected and processed according to established procedures (Busby and others, 1983). Isotope analyses were made by Tritium Laboratory, Miami, Fla.; Environmental Isotopes Laboratory, Waterloo, Ontario, Canada; and Geochron, Cambridge, Mass. The procedure utilized by the Environmental Isotopes Laboratory and Geochron required direct precipitation in the field of the inorganic carbon species as strontium carbonate, which was then analyzed in the laboratory for $\delta^{13}\text{C}$ and carbon-14 (Busby and others, 1983). Alternatively, unprocessed water samples were shipped to Tritium Laboratory where a gas-stripping technique was used to extract the inorganic carbon species prior to analysis (Miami Radiocarbon/Tritium Laboratory, 1973). A comparison between the two analytical methods in recovering the ^{14}C in dissolved inorganic carbon (DIC) is provided in Burt and others (1987, table 10). The analytical values for chemical constituents are reported in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g/L}$) except as noted below.

In this report, $\delta^{13}\text{C}$ (in DIC), deuterium, and oxygen-18 are reported as a δ -value expressed in parts per thousand (per mil) relative to internationally accepted standards. These δ values are calculated as follows (Fritz and Fontes, 1980):

$$\delta_x = \frac{R - R_{\text{std}}}{R_{\text{std}}} \times 1000 \quad (1)$$

where R is the sample isotopic ratio for $^{13}\text{C}/^{12}\text{C}$, $^2\text{H}/^1\text{H}$, or $^{18}\text{O}/^{16}\text{O}$; R_{std} for $^2\text{H}/^1\text{H}$ and $^{18}\text{O}/^{16}\text{O}$ is the Vienna Standard Mean Ocean Water standard, and R_{std} for $^{13}\text{C}/^{12}\text{C}$ is the Pee Dee Belemnite standard.

Carbon-14 concentration is expressed as a percentage of the modern atmospheric carbon-14, based on the National Institute of Standards and Technology oxalic acid standard. Tritium concentrations were measured but are reported in Tritium Units (T.U.), where one T.U. corresponds to 1 tritium atom in 10^{18} stable hydrogen atoms.

Saltwater-Encroachment Mechanisms

There are several possible mechanisms to account for the presence of saltwater in the UPZ of the Upper Floridan aquifer in the study. These include:

1. The equilibrium between freshwater and saltwater heads in a coastal aquifer creates a zone where freshwater and saltwater are present under steady-state conditions. In coastal aquifers that crop out in the ocean, there is a natural interface between fresh ground water flowing oceanward from inland areas of recharge, and saltwater in the aquifer that resists that seaward flow. The fresh ground water tends to float on saltwater, because of the density difference of the two solutions (freshwater= 1.000 g/cm^3 ; saltwater= 1.025 g/cm^3). This density difference can be used to describe the position of the freshwater-saltwater interface according to the Ghyben-Herzberg relation (Carlston, 1963). This relation states that for each foot of freshwater head above sea level, there is 40 ft of freshwater below sea level above the saltwater interface. This principle, however, assumes a steady-state condition in the aquifer. Because geologic and hydrologic processes are dynamic, although slow, the interface is never precisely one of steady state. It may, however, approach steady-state conditions compared to the effects of pumpage on the system.

2. The sediments that compose the Upper Floridan aquifer were deposited in a marine environment, trapping saltwater in the pore spaces. This water, also known as connate water, is thought to have been flushed out of the pore spaces following global sea-level decline. Because of its lower permeability, however, the lower unit of the Upper Floridan aquifer may be incompletely flushed (Siple, 1965).

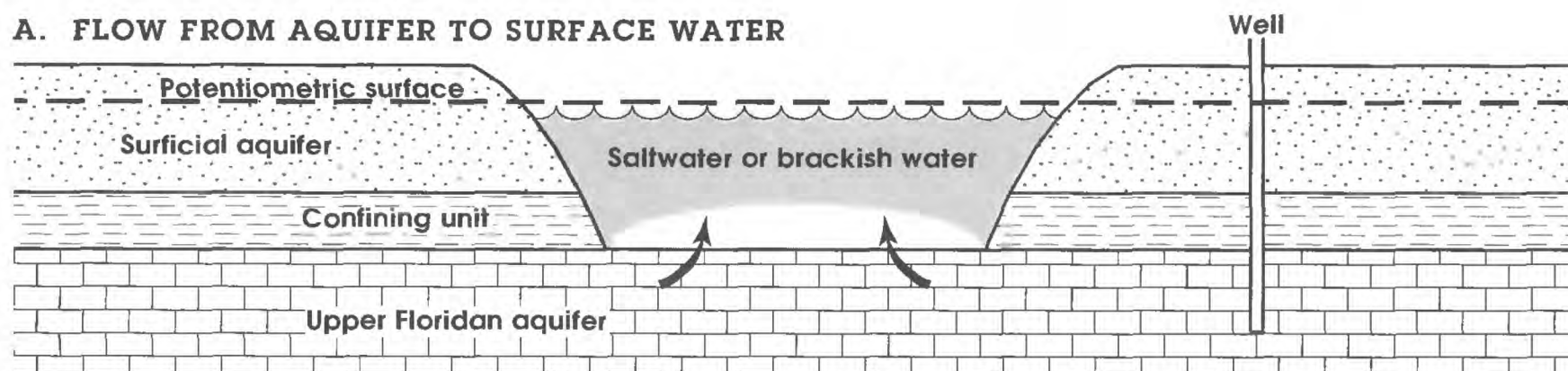
3. The proximity of water-bearing strata in the Hawthorn Formation and the UPZ to the bottom of tidally scoured creeks makes the aquifer susceptible to intrusion or encroachment by high-salinity surface water. During the Pleistocene epoch, sea level lower than present (1996) may have resulted in erosion of the Hawthorn Formation as streambeds adjusted to new levels (Siple, 1965). Additionally, present-day currents resulting from large tidal fluctuations (6 to 8 ft over a 12-hr period) may contribute to additional scouring of parts of the confining unit from the top of the limestone aquifer.

Dredging activities also may have contributed to the breaching of the Hawthorn Formation. The river beds in this area were utilized as a source of phosphate ore in the late 1800's; large quantities of this ore are minable at the top of the Hawthorn Formation. Additionally, parts of the Beaufort River near the town of Port Royal were dredged to form a turning basin in the late 1950's; during this time, limestone was observed in the dredge spoil material (G.E. Siple, U. S. Geological Survey, written commun., 1960). Possible mechanisms of local inflow and outflow to the aquifer under this scenario are shown in figure 6. Where the potentiometric surface of the aquifer is above sea level, the flow of water is from the aquifer (fresh) to the saltwater surface-water body (fig. 6A). Where the potentiometric surface is below sea level, flow is from the saltwater surface-water body into the aquifer (fig. 6).

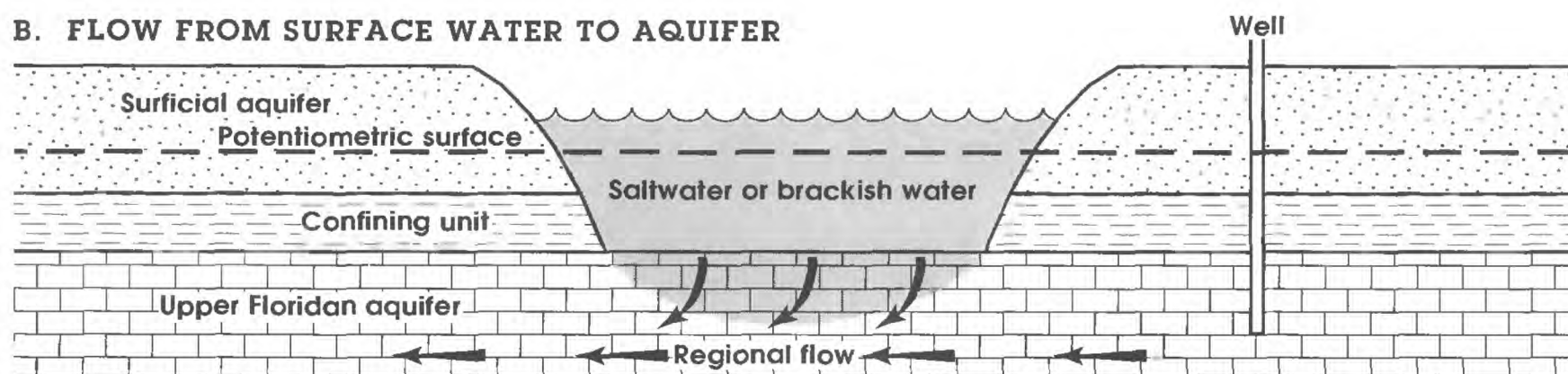
Marine seismic surveys made by the SCDNR-WRD in the saltwater creeks and estuaries in the area indicated that the Hawthorn Formation is absent beneath some parts of the Beaufort River. These areas are where the top of the aquifer is 30 ft or less bsl and the aquifer is more susceptible to saltwater contamination (South Carolina Water Resources Commission, 1972). Additional marine seismic surveys conducted for this study by Dr. Jim Henry of the Skidaway Oceanographic Institute indicated that the top of the aquifer probably is exposed or nearly exposed in the Coosaw River, and possibly in other deep tidal streams (Hughes and others, 1989).

4. In areas where saltwater is present in the aquifer adjacent to freshwater, ground-water withdrawal can cause lateral and(or) vertical movement of the saltwater (figs. 6C and 6D). This water may be unflushed formational (connate) water or water that has moved into the aquifer under any of several mechanisms, including those stated above. Lateral movement (saltwater encroachment) occurs where ground water moves toward a pumped or non-pumped well from adjacent areas. Vertical movement (saltwater intrusion) can occur in a well at a point that is open to more than one water-bearing zone or where saltwater is present beneath freshwater. Landmeyer (1992) showed that in wells open to parts of the Upper Floridan aquifer that contain freshwater

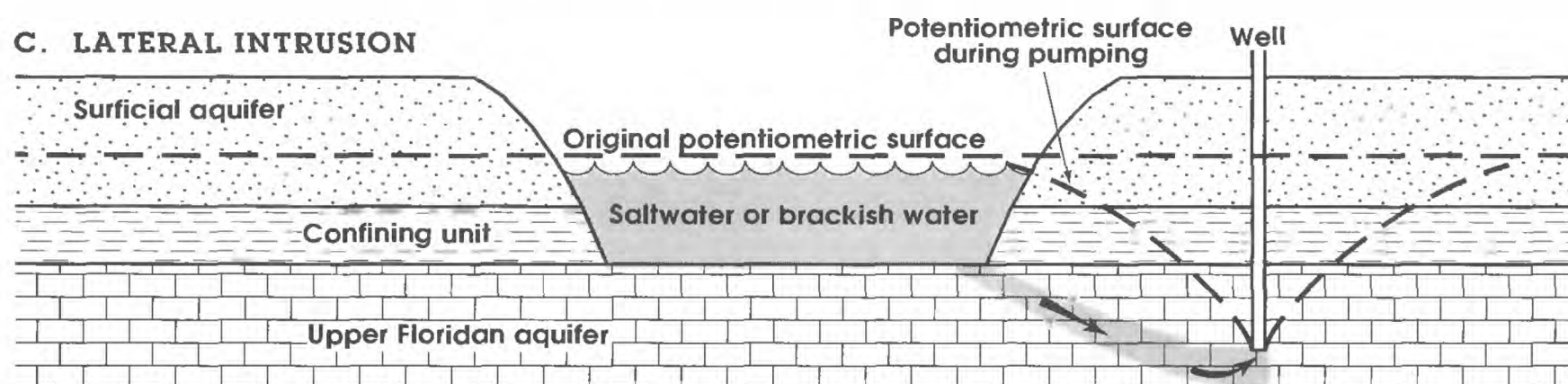
A. FLOW FROM AQUIFER TO SURFACE WATER



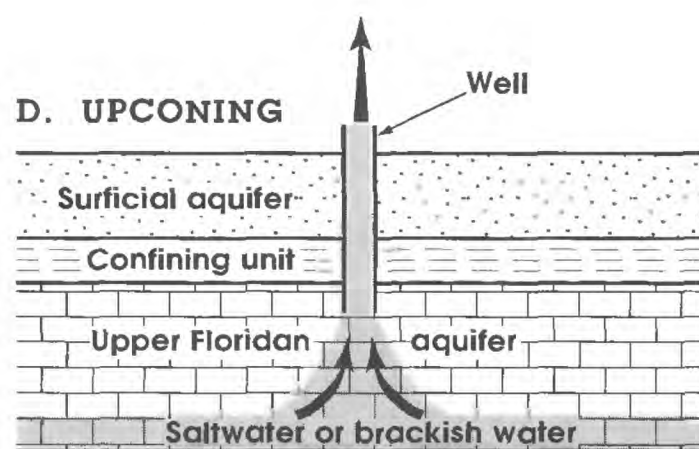
B. FLOW FROM SURFACE WATER TO AQUIFER



C. LATERAL INTRUSION



D. UPCONING



E. IMPROPERLY COMPLETED WELL

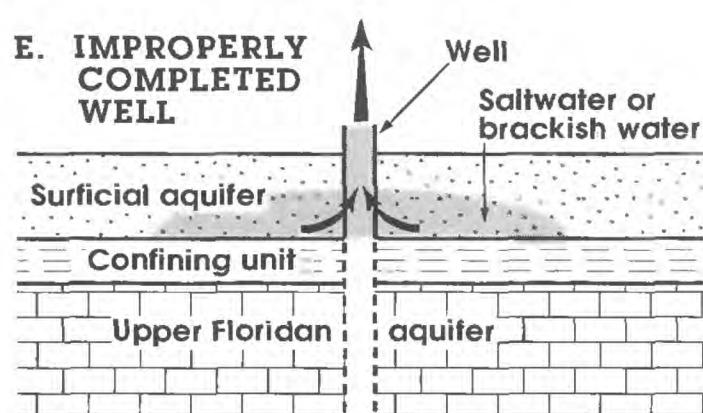


Figure 6. Possible mechanisms of local movement of ground-water recharge to and discharge from the Upper Floridan aquifer.

and saltwater, the lowering of the freshwater head in the upper part of the aquifer may allow the saltier connate water to move upward.

5. Finally, improperly grouted wells may allow the movement of saltwater along the well casing into the aquifer (fig. 6E).

Distribution of Selected Water-Chemistry Constituents

Chloride concentrations were used to locate the freshwater-saltwater mixing zone in the aquifer beneath Port Royal Sound. The concentration of chloride in the top of the UPZ is highest (greater than 5,000 mg/L) in an area beneath near-shore areas on the eastern edge of Port Royal Sound (fig. 7). A study of ground-water conditions in that area shows chloride concentrations on that same order of magnitude beneath St. Phillips and St. Helena Islands (Hassen, 1985), indicating that the area having water in the same strata of relatively high chloride is not only present at well BFT-1680 (chloride concentration of 8,100 mg/L). Chloride concentration also tends to be relatively high in the aquifer beneath much of Parris Island and Port Royal Island. There is a sharp decrease in the chloride concentration to the southwest across Hilton Head Island and to the northeast toward St. Helena Island.

Chloride concentration in water from the base of the UPZ generally is much higher than that near the top of the UPZ (fig. 8). Two zones having water of extremely high-chloride concentration were observed: one beneath Port Royal Sound, and another beneath northern Parris Island and southern Port Royal Island. The former extends beneath most of Port Royal Sound. It has a similar configuration as the area of high chloride concentration in water from the aquifer above it, although it is farther to the west. A chloride concentration gradient from 10,000 mg/L to 100 mg/L is located within 2 mi of Hilton Head Island. The 250 mg/L isochlor (line of equal chloride concentration) denotes the maximum contamination level for drinking water set by SCDHEC.

Another constituent often measured to determine the extent of the encroachment of saltwater is total dissolved solids (TDS). Smith (1988) used TDS isopleths (line of equal TDS) to estimate the rate of saltwater movement beneath Port Royal Sound in his ground-water-flow model of the Upper Floridan aquifer in this area. The areal distribution of TDS concentration in water from the top and base of the UPZ (figs. 9 and 10) mimics that of the chloride isochlors (figs. 7 and 8).

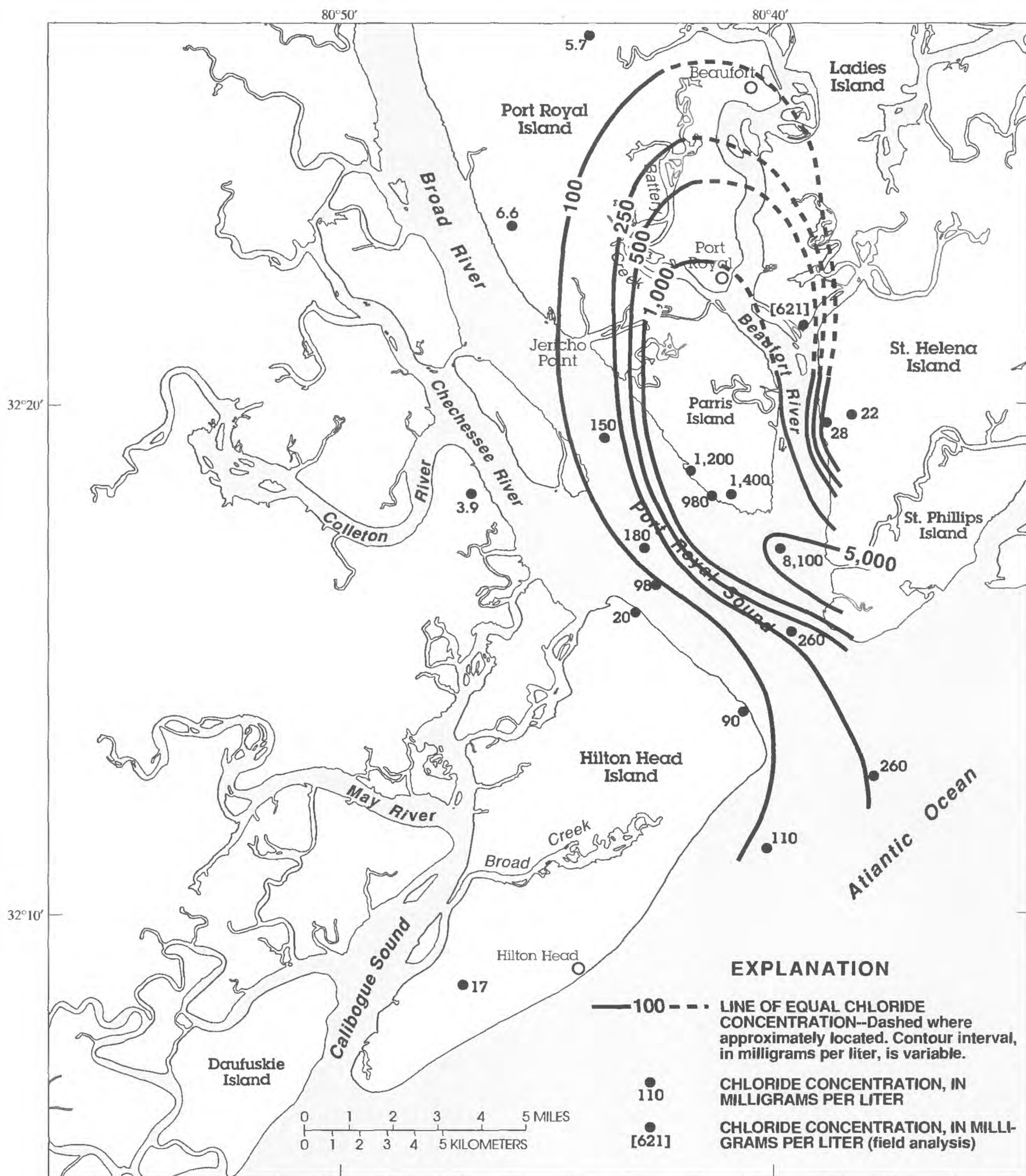


Figure 7. Distribution of chloride concentrations in the top of the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984.

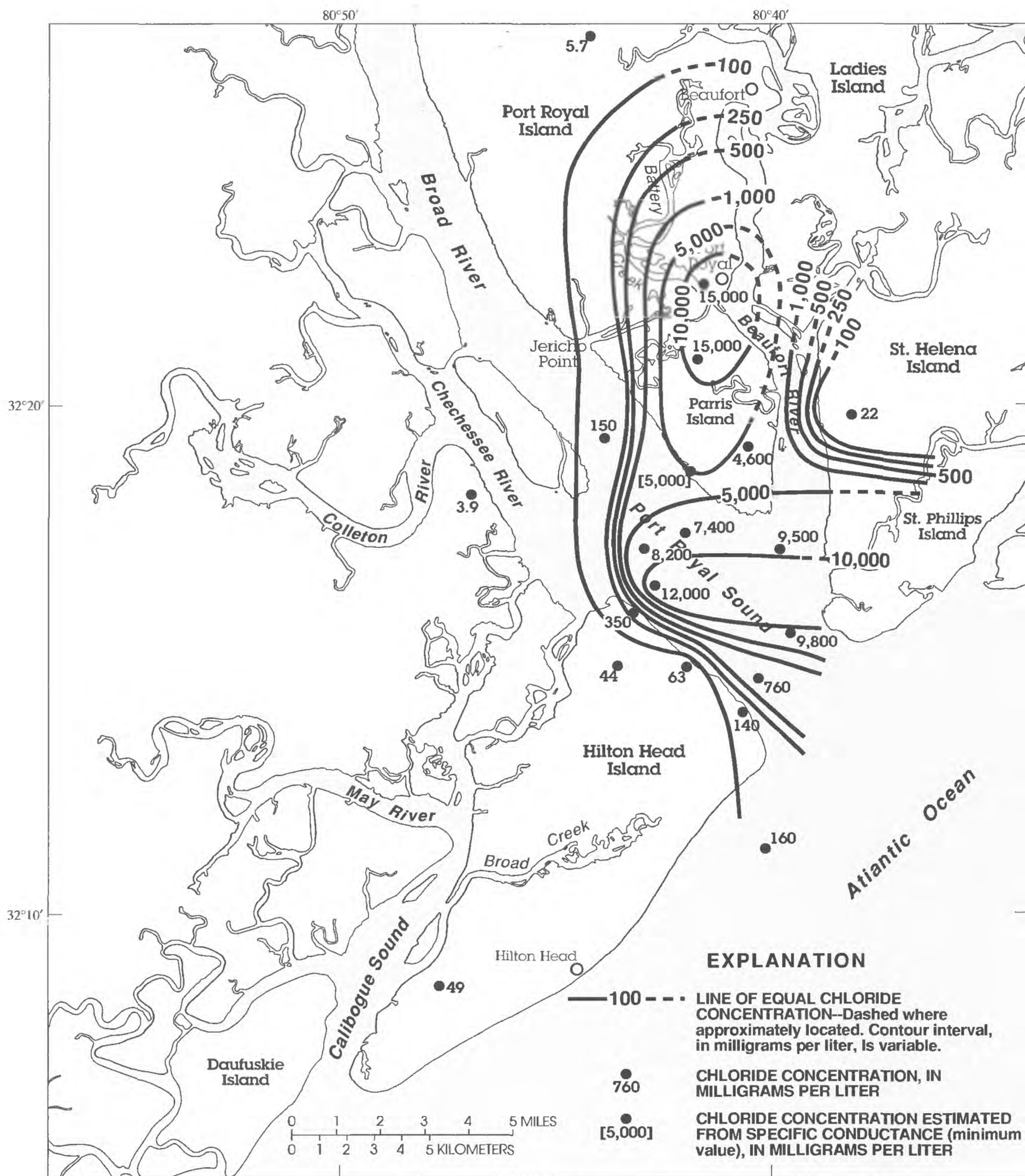


Figure 8. Distribution of chloride concentrations in the base of the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984.

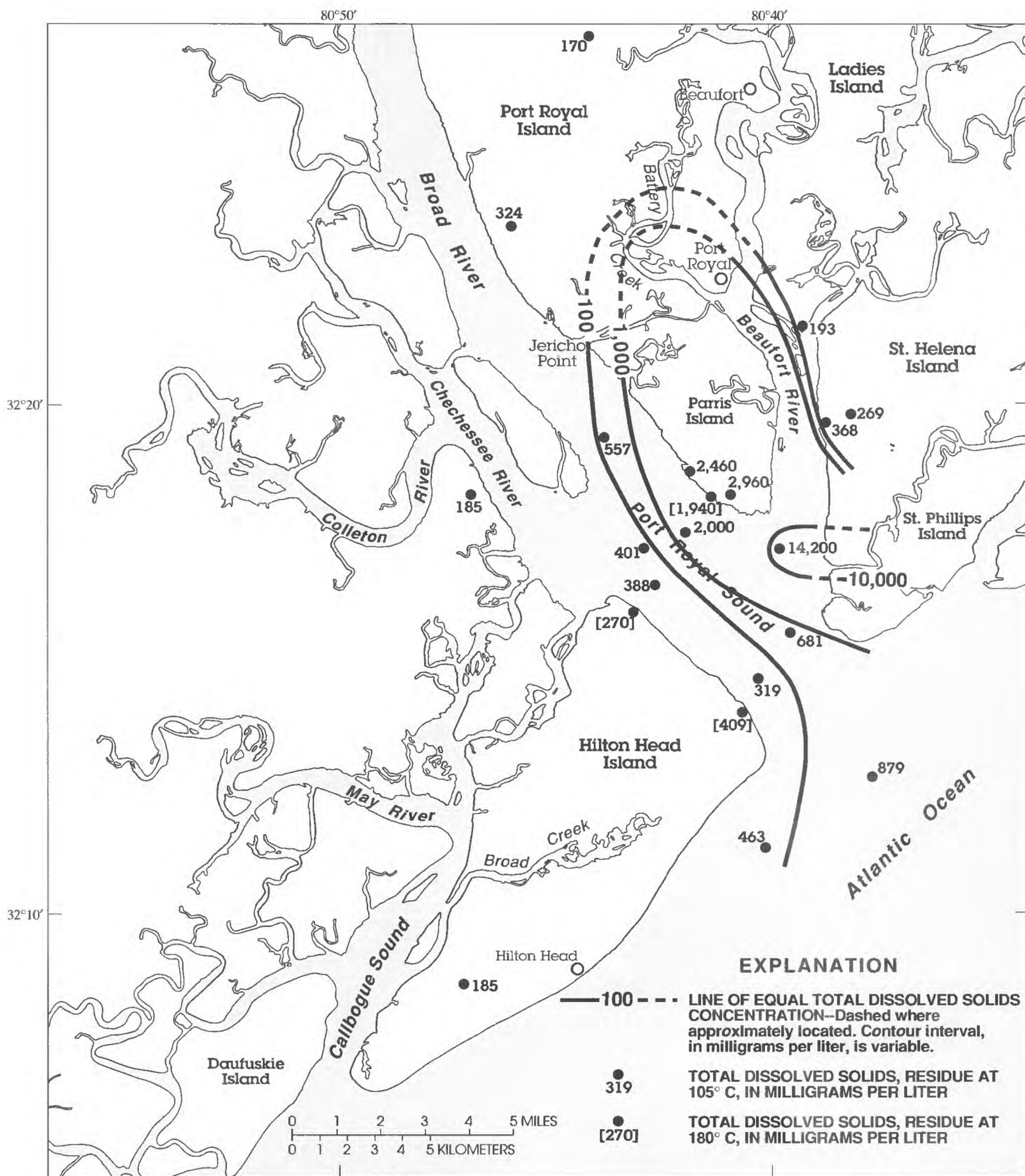


Figure 9. Distribution of total dissolved solids concentrations in the top of the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984.

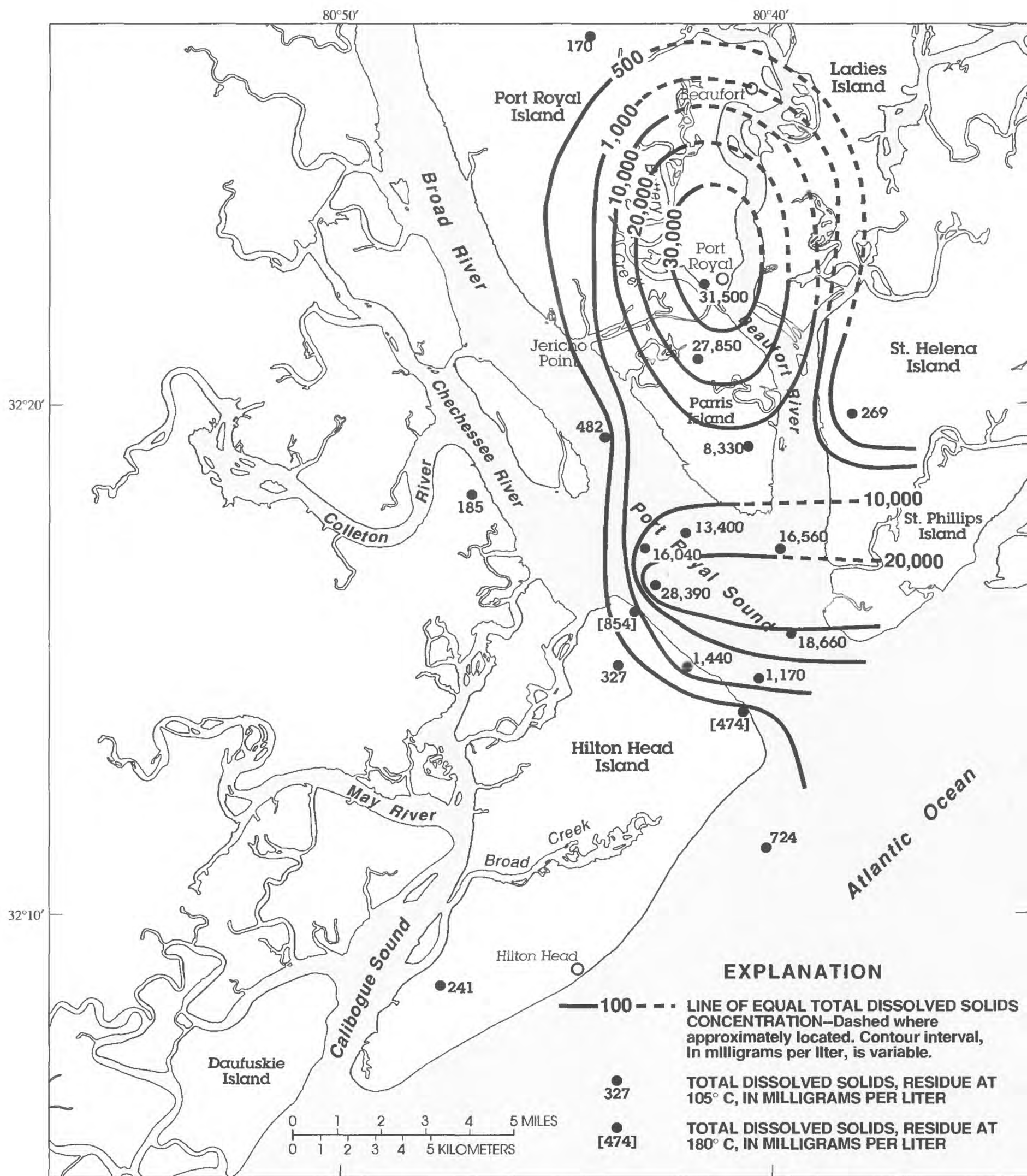


Figure 10. Distribution of total dissolved solids concentrations in the base of the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984.

The configuration of the freshwater-saltwater mixing zone in 1984 was geographically near and similar in shape compared to the theoretical, steady-state interface estimated by Smith (1988) prior to initial pumping of the aquifer in the late 1800's. This estimate was made by simulating the predevelopment water level, and then moving the no-flow boundary that represented the freshwater-saltwater interface until the simulated water level matched that estimated for the aquifer in 1984. This method gives an approximate position of a sharp interface. In reality, freshwater and saltwater mix in a broader zone of diffusion about the theoretical sharp interface. This mixing zone is large in the Upper Floridan aquifer because of the large porosity of the aquifer. The presence of saltwater beneath this area of Port Royal Sound may result from steady-state flow conditions and not the result of man-induced movement of saltwater. In the base of the aquifer, water adjacent to the north end of Hilton Head is high in salinity compared to most of the water from wells on the island. As ground water flows to the southwest, following the present pumping-induced hydraulic gradient, the potential exists for increases in chloride concentration in water from the Upper Floridan aquifer under Hilton Head Island.

Dissolved iron concentrations exceed the SCDHEC concentration of 0.3 mg/L for drinking water at the following sites: BFT-121, BFT-453, BFT-787, BFT-1841 (fig. 5), and HAM-122 (fig. 1). Elevated concentrations of dissolved iron in water from the Upper Floridan aquifer has been documented for Ladies and St. Helena Islands by Hassen (1985), and concentrations are distributed randomly over the islands. The areal distribution of iron concentration in water from the Upper Floridan aquifer may represent the variability in the dissolution and precipitation of iron in the aquifer. Variability in dissolution may result from variability in the distributions of ferric oxyhydroxides and organic material in the aquifer. Where these compounds occur together, microbially mediated iron reduction (and subsequent release into solution) coupled to the oxidation of the organic material tends to occur (Chapelle and Lovely, 1992). Elevated iron concentrations in water also may reflect contamination from old well casings, although this seems unlikely because of the measures taken to purge wells before sampling.

Concentrations of manganese in water from the Upper Floridan aquifer greater than the SCDHEC standard of 50 $\mu\text{g/L}$ for drinking water is found from wells BFT-1841 and HAM-122 (table 5). Water from a well farthest upgradient (HAM-122 from the predevelopment map) may reflect the chemistry of recently recharged shallow ground water. Although BFT-1841 is not located near the regional recharge area of the aquifer, water from the well has a high manganese concentration. Water levels in the Parris Island area, where BFT-1841 is located, have a downward vertical gradient. Because the confining unit is thin or absent in this area, there may be direct recharge to the Upper Floridan aquifer beneath Parris Island.

Hydrogen sulfide, which imparts a rotten-egg odor to water and possesses corrosive properties affecting plumbing and fixtures, is formed when sulfate is reduced to sulfide anaerobically by sulfate-reducing microorganisms. Although the presence of hydrogen sulfide in water does not constitute a health hazard (and is not included on the

SCDHEC list of water-quality standards), it does constitute an aesthetic water-quality problem in the area. Seawater that entered the aquifer serves as a potential source of sulfate, and anaerobic aquifer conditions facilitate the production of hydrogen sulfide where saltwater encroachment has occurred. An additional source of sulfate could be provided by the gypsum in the carbonate material of the Upper Floridan aquifer. Gypsum is present in the limestone beneath all of Hilton Head Island, and may account for the occurrence of hydrogen sulfide in ground water from the Upper Floridan aquifer in areas of no saltwater encroachment.

There is a clear gradation in the types of water within the aquifer that corresponds to the location of the wells. Water having the highest chloride concentration plots on a trilinear diagram closest to the point that represents average seawater. Those farthest from the influence of saltwater encroachment plot closest to the area that would represent ideal freshwater. The linear trend of plotted points between mean seawater and inland, freshwater well HAM-122 indicates that mixing of seawater with freshwater is the dominating process controlling the chemistry of the major ions in the aquifer (fig. 11).

CHLORIDE FLUCTUATIONS IN THE UPPER FLORIDAN AQUIFER

To clarify the configuration of the freshwater-saltwater interface, profiles of specific conductance using a YSI Salinity-Conductance-Temperature meter were constructed for several wells near Port Royal Sound. Specific conductance and temperature were obtained to a maximum depth of 250 ft at 5-ft intervals. Representative profiles are shown in figure 12. Because these wells were drilled into the lower permeable zone of the Upper Floridan aquifer as determined from the gamma-ray and drillers logs of each well, the figure shows not only the specific conductance and chloride concentration in the well, but also the depth and thickness of the aquifer.

The water levels in wells tapping the Upper Floridan aquifer near Port Royal Sound oscillate about 3 to 4 ft as a result of tidal fluctuations of 6 to 8 ft and the local hydraulic connections between the surface-water bodies and the Upper Floridan aquifer. The effect of the tides on the water levels in wells open to the surficial aquifer system, the Hawthorn Formation, and the Upper Floridan aquifer varies as a function of the degree of connection or confinement. Hayes (1979) reported that the tidal efficiency of the Upper Floridan aquifer in the area (defined as the ratio of the amplitude of water-level fluctuation in a well to the amplitude of the corresponding tidal fluctuation in nearby surface water), ranges from less than 5 percent for wells a mile or more from tidally influenced surface water to more than 75 percent for wells a few hundred feet or less from tidally influenced surface water. He also reported a time lag of tidally induced water-level

EXPLANATION

- SAMPLE IN AREA ADJACENT TO PORT ROYAL SOUND
- ◆ SAMPLE FROM WELL KNOWN TO BE CONTAMINATED BY SALTWATER
- SAMPLE FROM AQUIFER BENEATH PORT ROYAL SOUND
- HAM-122
- AVERAGE SEA WATER

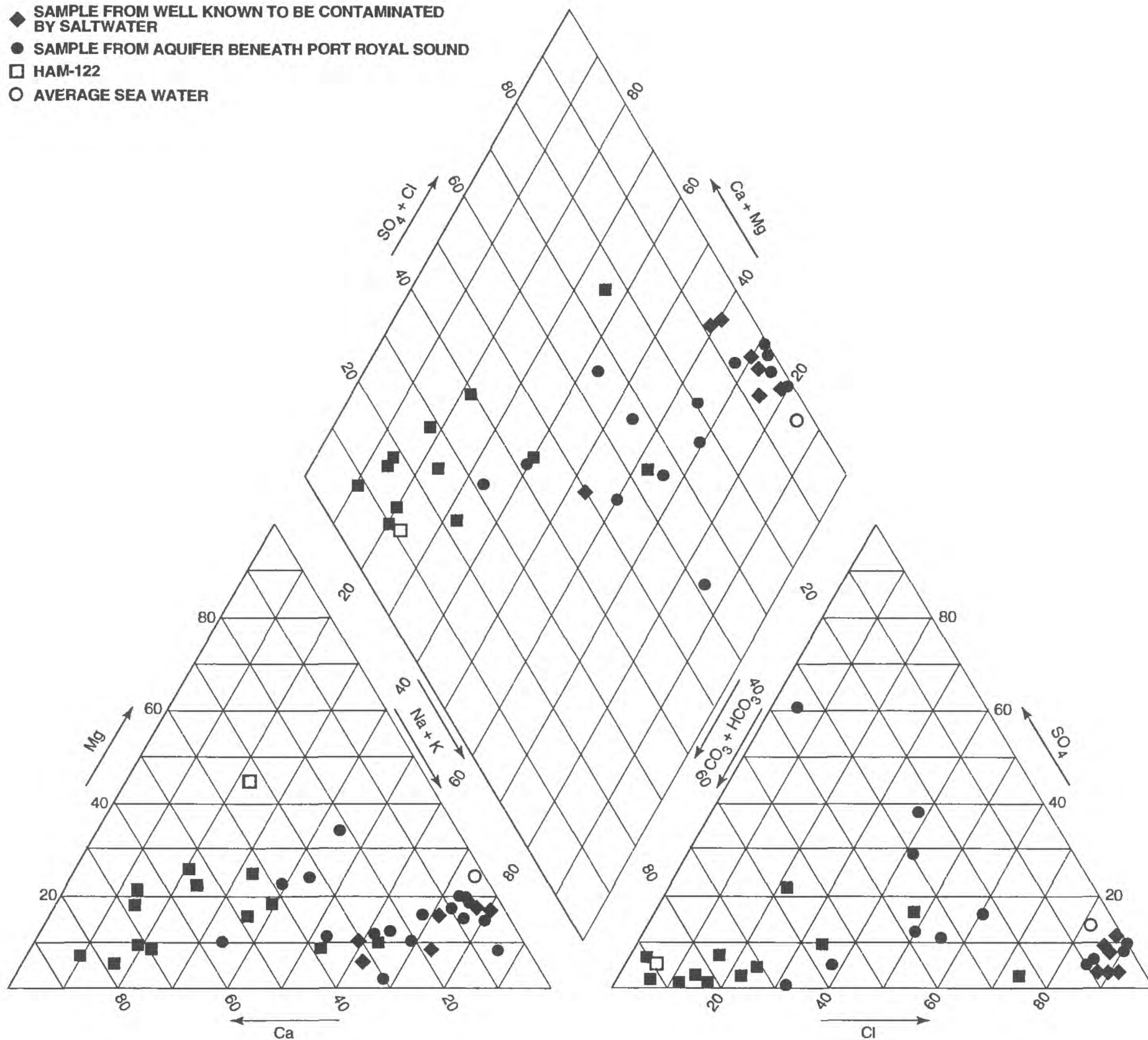


Figure 11. Trilinear diagram of percentage milliequivalents per liter of the major constituents of average seawater and ground water from the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984

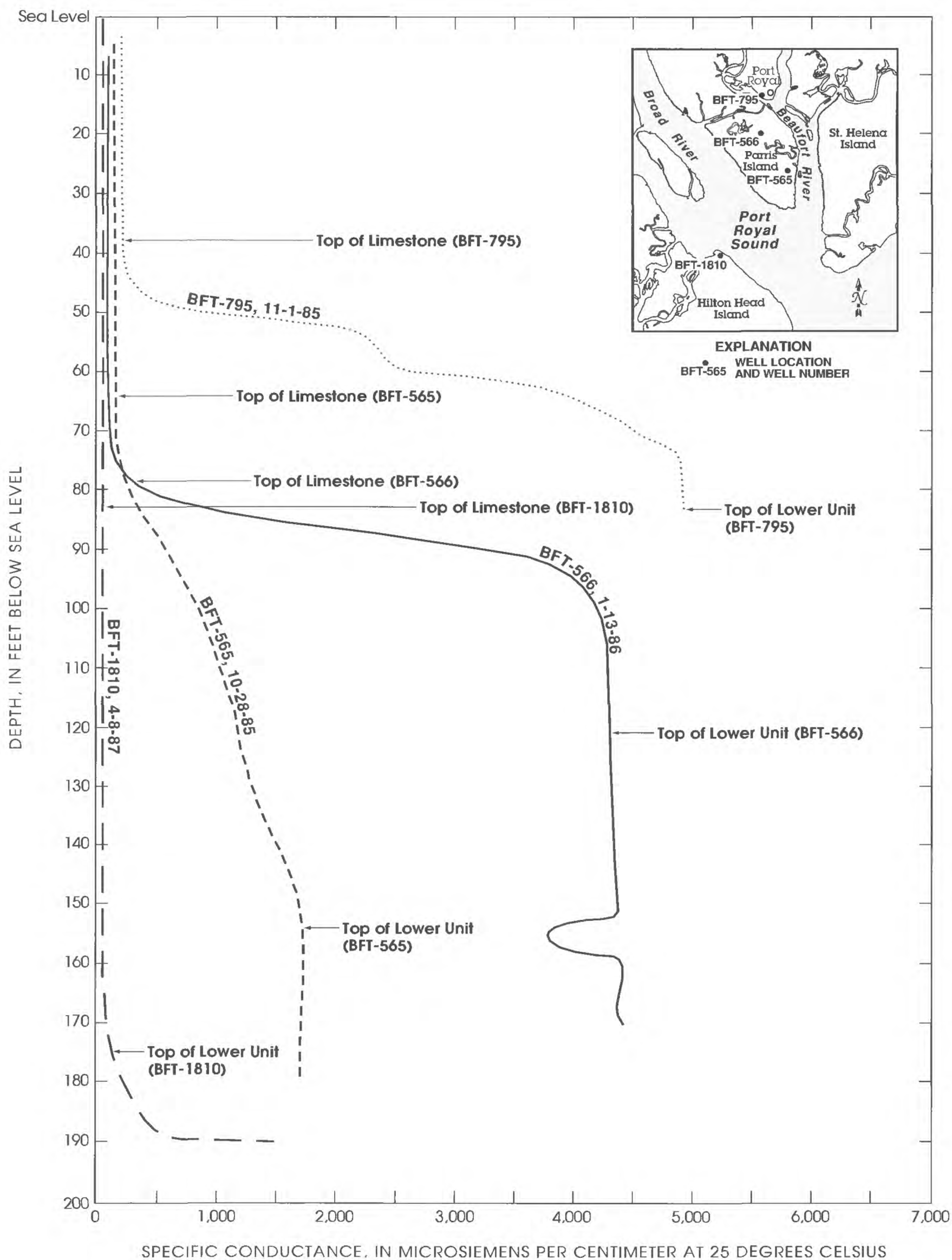


Figure 12. Specific conductance profiles and depths to the top of the upper permeable zone and the top of the lower permeable zone of the Upper Floridan aquifer for wells in the Port Royal Sound area, S.C.

change in the wells of 15 to 180 minutes between high- and low-tide levels and high- and low-water levels. The water level in well BFT-795, approximately 100 ft from the tidal channel at Port Royal (fig. 5), fluctuated 4.5 ft during one tidal cycle. This well is close to the area where there is evidence of breaching of the confining unit. Well BFT-1810, on northern Hilton Head Island, has a tidal fluctuation of 2 to 4 ft. This well is located approximately 200 ft from Port Royal Sound in an area where the confining unit is more continuous.

Specific conductance profiles were made over a period of several months for some wells in the study area. Although the pattern of each profile remained similar, the magnitude of specific conductance varied, depending on the magnitude of the tidal stage. Because this change in specific conductance had not been observed previously, these changes were monitored to record short-term variation in specific conductance in water from the well during a tidal cycle, and to monitor any long-term trends in the conductance.

Monitoring the specific conductance of water from BFT-1810, a non-pumped well, (fig. 5) depicted an interface between freshwater and saltwater in the well bore. Specific conductance ranged from about 450 $\mu\text{S}/\text{cm}$ in water in the cased part of the well and throughout most of the UPZ, to about 1,500 $\mu\text{S}/\text{cm}$ in the 175- to 202-ft depth (open hole). The monitor recorded specific conductance at depths of 170, 190, and 200 ft below the top of the casing. Specific conductance was recorded hourly at each level. The water level in the well also was monitored. A site description of the well is given below.

Site description	
Local number	BFT-1810
Location	Dolphin Head, Hilton Head Island, S.C.
Station Number	32160308043220
Location	Latitude 32°16'03", Longitude 80°43'22", Beaufort County Hydrologic Unit 03050208, Hilton Head, S.C.
Aquifer	Upper Floridan aquifer
Well Characteristics	Drilled observation well; 6-in diameter; 202-ft deep, cased to 105 ft, open hole 105 to 202 ft.
Datum	Land surface datum is 13 ft above sea level. Measuring point is top of casing, 0.8 ft above land surface datum.

Short-Term Chloride Fluctuations

Hourly values of specific conductance of water at the three probe depths in BFT-1810 and the water level in the well were plotted for March 13 to 31, 1993 (fig. 13). Observations are as follows:

- (1) Specific conductance at all three depths varied with the tidally-induced water-level fluctuations in the well;
- (2) At all three depths, the range of specific conductance values was similar; and
- (3) The time between changes in well water level (from changes in tidal water levels) and changes in specific conductance decreased with increasing probe depth.

The specific conductance at each depth fluctuates closely with ground-water levels in response to tidal fluctuations. Coastal South Carolina has asymmetrical tides, having a "high-high" and "low-high" water level, with some lag in time between a water-level response in the well at each depth with changes in the tidal basin. The length of time is inversely related to depth. The conductance of water at the 200-ft depth reaches its maximum at nearly the same time as the minimum water level of the well. The specific conductance at the 190-ft depth also reaches a maximum during the low water level in the well. At the 170-ft depth, the maximum specific conductance often correlates with maximum water level in the well. This may be explained by a more direct, hydrologic connection between the tidal basin and specific conductance at 170 ft, or a longer lag time between tidally induced well-water changes and changes in conductance.

These observations indicate that past methods of monitoring chloride concentrations in wells near tidally affected water bodies may not provide chloride data for accurate comparison to more recently collected chloride data. For example, monitoring-well-water samples in this area are often collected using a point sampler, which isolates a small volume of water (approximately 1 liter), that is brought to the surface and analyzed. However, because we know that tidal variations cause the specific conductance of water at a given point in a well to vary with time, small differences in the depth from which samples are collected could produce widely different results. In BFT-1810, for example, the range in variation would be approximately 50 to 100 $\mu\text{S}/\text{cm}$. This indicates that in order to have comparable conductance measurements for the same well over time, a point sample must be collected for chloride or specific conductance determination at the same depth and same tidal stage. One technique for overcoming uncertainties caused by tidal fluctuations and concentration gradients would be long-term continuous monitoring using specific conductance probes, as described above, and computing the daily mean specific conductance, and observing the relation between them and the daily mean water-level.

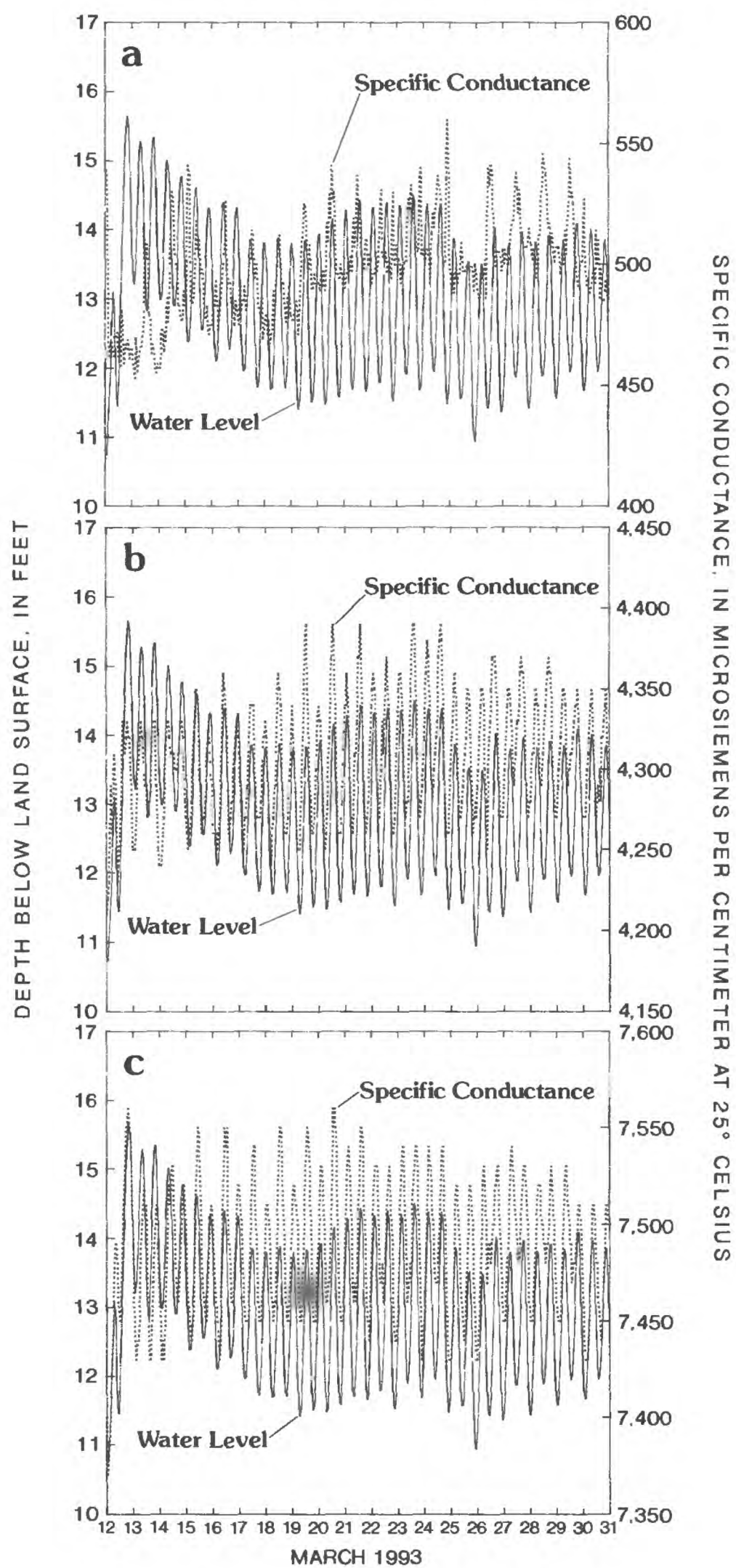


Figure 13. Hourly water levels and specific conductance at 170 (a), 190 (b), and 200 (c) feet below the top of casing at well BFT-1810, Hilton Head Island, S.C., March 13 - 31, 1993.

Methods used to study saltwater encroachment in this area have varied during the years, depending on the scope of the particular study. Even within a study, sometimes several methods are used, depending on the objectives of the study and the equipment available. Chloride samples have been collected by methods such as: (1) point sampling 5 to 20 ft below the water surface; (2) point sampling near the bottom of the casing; (3) sampling at the top of the casing by pumping the well, thereby obtaining a sample integrated throughout the entire open hole; and (4) using a submersible pump to sample from the bottom of the well, which also may integrate the sample throughout the well. Therefore, some of what appear to be highly significant changes in chloride concentrations in some wells can possibly be attributed to variations produced by the different methods used to collect the sample.

Long-Term Trends in Chloride Fluctuations

To evaluate possible long-term trends within the qualifications just described, the daily mean specific conductance and water levels were plotted between 1987 and 1993 for BFT-1810 (figs. 14). The water levels show seasonal fluctuations, with highest water levels occurring in the spring when rainfall is greatest, and ground-water usage lower, and lower water levels in summer when pumpage is greatest and rainfall lowest.

Specific conductance was measured at three depths in BFT-1810. Specific conductance at the 170-ft depth remained at about 500 $\mu\text{S}/\text{cm}$ during the period of record. Although there was little change at the 190-ft probe for several years, from 1990 to 1993, the specific conductance rose from about 500 to 4,000 $\mu\text{S}/\text{cm}$. The largest and most significant change occurred at the 200-ft depth. In 1989, 1990, and 1991, specific conductance gradually increased from 4,000 $\mu\text{S}/\text{cm}$ to nearly 10,000 $\mu\text{S}/\text{cm}$. Since 1991, the conductance has decreased to about 8,000 $\mu\text{S}/\text{cm}$ (fig. 14) and has remained stable.

This general increase in specific conductance suggests the movement of saltwater in the aquifer from offshore to beneath Hilton Head Island. The movement of the saltwater, however, is not during the period expected, when ground-water withdrawal on Hilton Head Island is at its greatest during the summer months. The change in specific conductance during 1990-1993 seems to have occurred independently of the seasonal water-level fluctuations, but the slight decrease in specific conductance near the end of water year 1991 occurred when the water level in the aquifer was greater than normal for that time of year. The higher water level was caused by above-average rainfall and use of the aquifer for water supply was reduced from that of previous years.

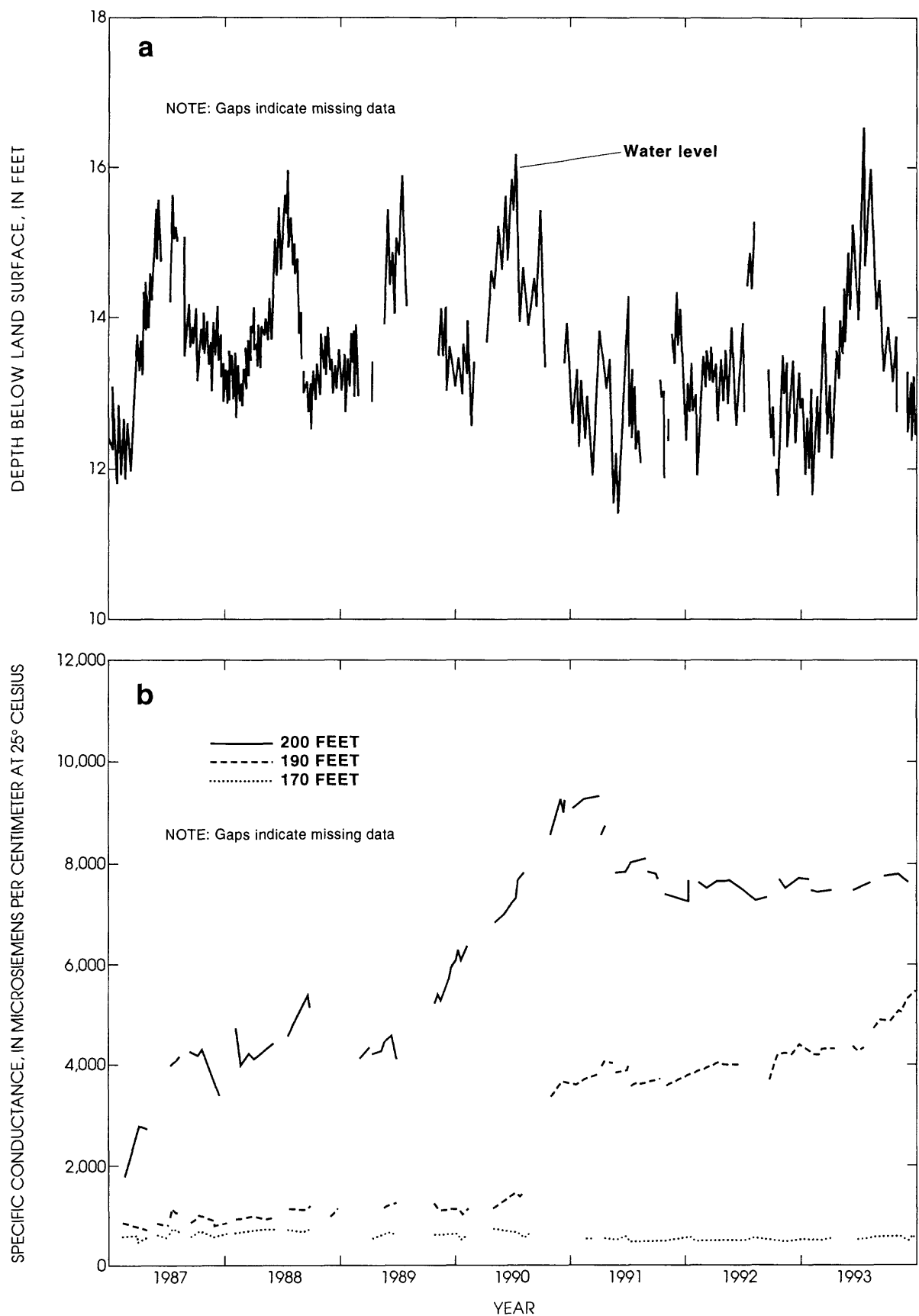


Figure 14. Daily mean values for water level (a) and specific conductance (b) at 170, 190, and 200 feet below the top of casing at well BFT-1810, Hilton Head Island, S.C., for 1987 to 1993.

SUMMARY

A study of the water chemistry and hydrogeologic characteristics of the Upper Floridan aquifer in the area of Port Royal Sound, Beaufort and Jasper Counties, S.C., was initiated in 1984. The study was designed to investigate the geologic, hydrologic, and geochemical characteristics, and the occurrence of chloride in the Upper Floridan aquifer in the Port Royal Sound area. Results of the study show trends and changes in water chemistry and chloride concentrations that have occurred as a result of withdrawal-induced saltwater encroachment and the effects of tidally induced chloride fluctuations in the upper permeable zone of the aquifer. Short-term and long-term fluctuations of chloride concentration in a continuously monitored observation well on the north end of Hilton Head Island nearest to the naturally occurring seawater in the aquifer are shown from 1987 to 1993.

The Port Royal Sound area includes Beaufort and Jasper Counties, the southernmost counties on the South Carolina coast, and is within the Sea Islands section of the Atlantic Coastal Plain physiographic province. The dominant physical feature of the area is Port Royal Sound, an estuary approximately 3 mi across at its confluence with the ocean, 4 mi across at its widest point, and extending 24 mi inland.

The Upper Floridan aquifer produces water of excellent quality throughout most of Beaufort and Jasper Counties, S.C. The towns of Hilton Head and Bluffton in Beaufort County rely solely on this aquifer as a source of water supply. Additionally, approximately 100 Mgal/d of high-quality water are withdrawn from the Floridan aquifer system in the vicinity of the city of Savannah, Ga., 25 mi southwest of Port Royal Sound. The approximate predevelopment potentiometric surface of the Upper Floridan aquifer indicated that regional ground-water flow of freshwater was seaward toward Port Royal Sound, and ground water discharged into the Sound under artesian pressure, thereby preventing any appreciable landward movement of the freshwater-saltwater interface and consequent degradation of the quality of water.

A cone of depression has been developing since 1880 because of withdrawals centered in Savannah, and the zero-foot contour has migrated northward into Beaufort and Jasper Counties. The cone of depression and head declines have reversed the predevelopment hydraulic gradient of the potentiometric surface in the aquifer from one of seaward (toward Port Royal Sound) to southwestward (from Port Royal Sound). Saltwater in the aquifer north of Port Royal Sound, present during predevelopment, is presently (1995) moving south toward the water-supply wells for the town of Hilton Head and for industries near Savannah.

Ground-water samples collected in the Upper Floridan aquifer in the Port Royal Sound area identified two areas with chloride concentrations above the standards set for drinking water. One area encompasses and extends slightly south of the theoretical, predevelopment steady-state freshwater-saltwater interface as indicated by numerical modeling. The other area is beneath the town of Port Royal, where the upper confining unit is thought to be thin or absent. In these areas, the decline in water levels caused by

ground-water withdrawals may have made it possible for water from tidal creeks to enter the Upper Floridan aquifer.

Many wells completed in the upper permeable zone of the Upper Floridan aquifer show a distinct specific-conductance profile. An observation well (BFT-1810) completed in the upper permeable zone of the Upper Floridan aquifer and instrumented with specific conductance probes at 170, 190, and 200 ft below land surface shows a distinct specific conductance profile with time. Specific conductance values ranged from approximately 450 $\mu\text{S}/\text{cm}$ near the top of the Upper Floridan aquifer to 1,500 $\mu\text{S}/\text{cm}$ near the lower, less permeable zone of the aquifer in late 1980. Specific conductance fluctuations at each depth closely followed the tidal cycles and varied regularly up to 100 $\mu\text{S}/\text{cm}$, with an increasing time lag between high and low tides and low and high specific conductance for progressively shallower depths. From October 1987 through September 1993, monitoring of BFT-1810 showed little change in conductance at the probe located 170-ft below land surface, while the 190- and the 200-ft probes showed increases to approximately 4,000 and 10,000 $\mu\text{S}/\text{cm}$, respectively. This well is located closet to one of the two plumes of saltwater delineated in the Upper Floridan aquifer, and the long-term chloride increases are a result of the movement of saltwater in the Upper Floridan aquifer toward Hilton Head Island under the influence of regional ground-water withdrawals.

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Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977*
[μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
Town of Beaufort	A	11-24-17	125	--	--	--	--	--	29	--
Bluffton, May River (flowing)	A	06-27-22	90	--	--	--	--	--	4.0	--
Okatie	A	06-27-22	165	--	--	--	--	--	5.0	--
Yemassee	A	11-24-17	85	--	--	--	--	--	4.9	--

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Non-carbonate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
Town of Beaufort	A	11-24-17	233	24	104	18	--	35	34	--
Bluffton, May River (flowing)	A	06-27-22	161	91	116	3.6	--	12	20	--
Okatie	A	06-27-22	171	102	145	0	--	8.2	27	--
Yemassee	A	11-24-17	227	108	160	8.9	--	4.0	25	--

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
Town of Beaufort	A	11-24-17	0.54	3.7	--	Tr	29	--	63
Bluffton, May River (flowing)	A	06-27-22	0.09	10	--	1	34	--	17
Okatie	A	06-27-22	0.09	8.5	--	Tr	32	--	19
Yemassee	A	11-24-17	0.28	11	--	0.25	--	--	23

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
BFT-287	B	03-24-55	194	--	--	--	7.7	--	34	0.2
BFT-57	B	07-23-55	161	--	--	--	7.8	--	6.8	0.4

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Non-carbonate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
BFT-287	B	03-24-55	306	196	232	--	--	1.5	66	--
BFT-57	B	07-23-55	176	96	130	--	--	7	24	--

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
BFT-287	B	03-24-55	0.17	7.6	2	0.8	44	24	--
BFT-57	B	07-23-55	0.47	8.3	2	0.1	46	11	--

Table 2.-- *Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μ S/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
BFT-22	C	01-27-56	84	--	--	--	7.1	371	9.0	0.4
BFT-29	C	07-11-56	87	--	--	--	--	533	56	--
BFT-100	C	10-21-53	200-235	--	--	--	7.8	243	3.5	0.5
BFT-102	C	04-21-55	300	--	--	--	7.2	1,170	282	0.1
BFT-102	C	08-27-54	--	--	--	--	--	939	56	0.0
BFT-103	C	08-27-54	96	--	--	--	7.2	4,130	22	0.1
BFT-104	C	10-20-54	100	--	--	--	7.3	216	6.2	--
BFT-106	C	03-25-55	81	--	--	--	7.6	274	24	0.0
BFT-114	C	04-21-55	100	--	--	--	7.5	256	8.5	0.1
BFT-117	C	03-30-57	95	--	--	--	7.9	328	7.2	0.3
BFT-129	C	07-22-55	100	--	--	--	7.1	--	8.0	0.4
BFT-131	C	03-28-56	113	--	--	--	7.5	305	7.8	0.1
BFT-132	C	00-00-56	103	--	--	--	7.3	305	7.0	0.1
BFT-133	C	03-15-56	110	--	--	--	7.5	353	38	0.4
BFT-138	C	07-11-56	400-600	--	--	--	7.4	444	9.5	0.5

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹ .	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbon- ate (mg/L)	Carbonate (mg/L)	Non-carbon- ate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
BFT-22	C	01-27-56	244	176	225	--	--	0.1	55	0.53
BFT-29	C	07-11-56	--	200	--	--	--	44	--	--
BFT-100	C	10-21-53	162	94	131	--	--	7.6	21	0.15
BFT-102	C	04-21-55	815	294	146	--	--	18	107	0.09
BFT-102	C	08-27-54	--	250	146	--	--	13	94	--
BFT-103	C	08-27-54	--	180	208	--	--	8	--	1.9
BFT-104	C	10-20-54	--	99	121	--	--	1	37	--
BFT-106	C	03-25-55	155	105	114	--	--	4.9	38	0.08
BFT-114	C	04-21-55	148	120	147	--	--	1.5	44	0.29
BFT-117	C	03-30-57	233	152	201	--	--	0.2	51	0.51
BFT-129	C	07-22-55	--	205	238	--	--	0.4	--	--
BFT-131	C	03-28-56	196	138	172	--	--	0.7	51	0.46
BFT-132	C	00-00-56	185	144	178	--	--	0.9	51	0.96
BFT-133	C	03-15-56	195	124	132	--	--	3.9	32	13
BFT-138	C	07-11-56	269	95	263	--	--	5.3	18	--

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;

Well number	Source ¹ .	Date	Iron, dissolved (mg/L)	Magne- sium, dis- solved (mg/L)	Potas- sium, dis- solved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
BFT-22	C	01-27-56	0.19	9.1	2.7	0.2	5.1	8.2	--
BFT-29	C	07-11-56	--	--	--	--	--	--	--
BFT-100	C	10-21-53	0.10	10	--	0.6	45	13	--
BFT-102	C	04-21-55	0.00	6.5	1.2	0.6	12	113	--
BFT-102	C	08-27-54	--	3.6	--	0.0	--	--	--
BFT-103	C	08-27-54	0.20	--	--	0.0	--	--	--
BFT-104	C	10-20-54	--	1.7	--	0.5	--	--	--
BFT-106	C	03-25-55	0.01	2.5	0.7	0.0	10	13	--
BFT-114	C	04-21-55	0.00	2.6	0.8	0.2	13	4.6	--
BFT-117	C	03-30-57	0.17	5.9	3.2	1.2	44	11	--
BFT-129	C	07-22-55	0.00	--	--	1.0	--	--	--
BFT-131	C	03-28-56	0.04	2.8	0.7	0.4	40	5.9	--
BFT-132	C	00-00-56	0.06	4.4	0.8	0.4	26	5.6	--
BFT-133	C	03-15-56	0.18	11	3.7	0.3	14	19	--
BFT-138	C	07-11-56	0.03	12	10	0.2	33	60	--

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*
 [μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
 USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
BFT-143	C	07-11-56	110	--	--	--	7.6	--	12	0.8
BFT-146	C	07-20-56	265	--	--	--	7.6	329	20	0.3
Beaufort Naval Air Station	C	04-05-54	--	--	--	--	--	--	9	--
BFT-17	C	07-11-56	--	--	--	--	7.5	--	6.5	--
BFT-18	C	07-26-56	--	--	--	--	7.3	297	7.5	--
Beaufort City, mixed water	C	12-12-51	--	--	--	--	7.0	294	20	0.2
BFT-155	C	06-28-57	60	--	--	--	7.0	--	2.2	0.2
BFT-173	C	09-10-58	299	--	--	--	7.4	--	7.0	0.2
BFT-182	C	09-10-58	52	--	--	--	7.3	339	17	0.1
BFT-182	C	07-11-56	50	--	--	--	7.3	349	18	0.2
BFT-183	C	09-10-58	52	--	--	--	--	--	16	0.1
BFT-184	C	09-10-58	52	--	--	--	--	--	17	0.1
BFT-184	C	07-11-56	50	--	--	--	7.3	241	12	0.2
USMCRD Composite sample, raw water	C	01-03-56	90-100	--	--	--	7.4	387	14	0.1

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*
[μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbon- ate (mg/L)	Carbonate (mg/L)	Non-carbon- ate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
BFT-143	C	07-11-56	--	103	270	--	--	6.5	19	--
BFT-146	C	07-20-56	198	124	166	--	--	5.4	34	0.10
Beaufort Naval Air Station	C	04-05-54	--	144	183	--	--	1	--	--
BFT-17	C	07-11-56	--	69	218	--	--	2.6	15	--
BFT-18	C	07-26-56	--	110	174	--	--	3.0	--	0.05
Beaufort City, mixed water	C	12-12-51	171	107	98	--	--	31	40	--
BFT-155	C	06-28-57	--	146	216	--	--	1.6	50	--
BFT-173	C	09-10-58	--	87	182	--	--	1.2	--	--
BFT-182	C	09-10-58	--	138	177	--	--	6.1	55	0.00
BFT-182	C	07-11-56	200	156	166	--	--	11	61	0.35
BFT-183	C	09-10-58	--	118	121	--	--	11	--	--
BFT-184	C	09-10-58	--	130	123	--	--	8.7	--	--
BFT-184	C	07-11-56	132	102	114	--	--	5.9	40	0.07
USMCRD Composite sample, raw water	C	01-03-56	250	172	222	--	--	0.2	53	--

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued
[μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magne- sium, dis- solved (mg/L)	Potas- sium, dis- solved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
BFT-143	C	07-11-56	--	13	--	--	--	--	--
BFT-146	C	07-20-56	0.01	9.7	2.9	0.1	33	18	--
Beaufort Naval Air Station	C	04-05-54	--	--	--	--	--	--	--
BFT-17	C	07-11-56	--	7.8	--	--	--	--	--
BFT-18	C	07-26-56	0.01	--	--	1.0	--	--	--
Beaufort City, mixed water	C	12-12-51	0.54	1.7	16	0.3	9.4	--	--
BFT-155	C	0.54	0.02	5.4	--	0.7	--	--	--
BFT-173	C	09-10-58	--	--	--	1.0	--	--	--
BFT-182	C	09-10-58	--	0.5	--	2.5	--	--	--
BFT-182	C	07-11-56	0.03	1.0	0.6	1.2	7.1	9.9	--
BFT-183	C	09-10-58	--	--	--	1.5	--	--	--
BFT-184	C	09-10-58	--	--	--	0.7	--	--	--
BFT-184	C	07-11-56	0.01	0.5	0.4	0.6	7.5	6.7	--
USMCRD Composite sample, raw water	C	01-03-56	0.32	10	2.6	1.0	45	13	--

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued
[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μ S/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
USMCRD composite sample finished water	C	01-03-56	--	--	--	--	7.2	519	14	0.7
HAMPTON	C	05-24-54	667	--	--	--	7.8	395	3.4	1.2
HAM-76	C	04-21-44	667	--	--	--	--	--	4	--
JAS-1	C	06-14-48	503	--	--	--	--	--	6	--
JAS-5	C	06-14-48	300	--	--	--	--	--	6.5	--
JAS-15	C	04-21-44	--	--	--	--	--	--	7	--
JAS-18	C	01-24-58	--	--	--	--	7.3	305	6.0	0.0
Ridgeland well#73	C	04-21-44	--	--	--	--	--	--	7	--
Ridgeland Well #102	C	06-18-54	210	--	--	--	8.0	309	5.2	0.0
JAS-104	C	04-14-57	330	--	--	--	7.4	254	4.2	0.3
JAS-104	C	05-02-57	330	--	--	--	7.1	265	2.5	0.4
JAS-104	C	05-03-57	330	--	--	--	7.2	271	6.5	0.4
Ridgeland	C	10-11-56	459	--	--	--	7.3	307	5.8	0.1
Hardeeville	C	10-11-56	--	--	--	--	7.3	229	4.0	0.6

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*
 [µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
 USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbon- ate (mg/L)	Carbonate (mg/L)	Non-carbon- ate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
USMCRD composite sample, finished water	C	01-03-56	356	71	319	--	--	0.2	23	--
HAMPTON	C	05-24-54	258	34	247	--	--	6.0	9.1	0.11
HAM-76	C	04-21-44	--	98	183	--	--	2.0	--	--
JAS-1	C	06-14-48	--	--	--	--	--	--	--	--
JAS-5	C	06-14-48	--	--	--	--	--	--	--	--
JAS-15	C	04-21-44	--	129	187	--	--	2.0	--	--
JAS-18	C	01-24-58	--	--	190	--	--	0.2	--	--
Ridgeland Well #73	C	04-21-44	--	--	187	--	--	2.0	--	--
Ridgeland Well #102	C	06-18-54	198	147	187	--	--	1.8	46	0.09
JAS-104	C	04-14-57	161	103	145	--	--	5.9	28	--
JAS-104	C	05-02-57	--	110	147	--	--	7.6	--	--
JAS-104	C	05-03-57	--	108	151	--	--	--	28	--
Ridgeland	C	10-11-56	200	139	188	--	--	2.6	44	0.03
Hardeeville	C	10-11-56	154	80	133	--	--	6.0	19	0.12

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*
 [μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
 USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magne- sium, dis- solved (mg/L)	Potas- sium, dis- solved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
USMCRD composite sample finished water	C	01-03-56	0.30	3.4	1.8	0.6	53	98	--
HAMPTON	C	05-24-54	0.00	2.6	4.8	0.6	26	76	--
HAM-76	C	04-21-44	--	--	--	--	--	--	--
JAS-1	C	06-14-48	--	--	--	--	--	--	--
JAS-5	C	06-14-48	--	--	--	--	--	--	--
JAS-15	C	04-21-44	--	--	--	--	--	--	--
JAS-18	C	01-24-58	--	--	2.4	--	--	10	--
Ridgeland Well #73	C	04-21-44	--	--	--	--	--	--	--
Ridgeland Well #102	C	06-18-54	0.01	7.8	7.2	0.1	28	--	--
JAS-104	C	04-14-57	0.02	8.0	2.6	0.2	18	10	--
JAS-104	C	05-02-57	--	--	--	0.1	--	--	--
JAS-104	C	05-03-57	--	9.0	--	0.7	--	--	--
Ridgeland	C	10-11-56	0.00	7.1	2.4	1.1	34	11	--
Hardeeville	C	10-11-56	0.03	8.2	3.5	0.3	41	19	--

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*
 [μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
 USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
BFT-124	D	04-06-66	--	97	107	19.8	7.57	297	6.4	0.1
BFT-314	D	04-13-65	--	125	230	21.1	7.98	145	7.6	0.4
BFT-287	D	04-05-66	--	90	195	20.6	7.34	445	31	0.2
BFT-317	D	04-05-66	--	86	196	20.1	7.61	399	33	0.5
BFT-343	D	04-05-66	--	124	200	20.3	8.09	356	34	0.6
BFT-315	D	04-13-65	190	--	--	12.3	8.04	573	70	0.4
BFT-401	D	04-04-66	--	140	214	20.9	7.60	756	112	0.6

Table 2.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[μS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Non-car- bonate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, total (mg/L)
BFT-124	D	04-06-66	187	--	175	--	--	5.5	52	--
BFT-314	D	04-13-65	175	--	127	--	--	8.6	23	--
BFT-287	D	04-05-66	313	--	231	--	--	0.0	66	--
BFT-317	D	04-05-66	262	--	181	--	--	8.1	42	--
BFT-343	D	04-05-66	232	--	135	--	--	15	21	--
BFT-315	D	04-13-65	349	--	224	--	--	8.6	46	--
BFT-401	D	04-04-66	473	--	168	--	--	63	45	--

Table 2.--*Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magne- sium, dis- solved (mg/L)	Potas- sium, dis- solved (mg/L)	Nitrate, dissolved (mg/L)	Silica dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
BFT-124	D	04-06-66	--	1.3	0.6	0.0	7.8	4.8	--
BFT-314	D	04-13-65	--	8.4	2.2	0.1	47	15	--
BFT-287	D	04-05-66	--	5.0	1.9	0.0	36	20	--
BFT-317	D	04-05-66	--	10	2.3	0.1	32	29	--
BFT-343	D	04-05-66	--	13	3.1	0.8	27	32	--
BFT-315	D	04-13-65	--	19	3.2	0.3	34	44	--
BFT-401	D	04-04-66	--	11	5.0	0.4	25	99	--

Table 2.- *Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued*

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; $^{\circ}$ C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Temperature ($^{\circ}$ C)	pH (standard units)	Specific conductance (μ S/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)
BFT-121	E	01-14-77	105	--	--	--	--	240	7.2	0.1
BFT-458	E	10-21-74	71	--	--	--	--	272	5.1	0.6
BFT-459	E	11-15-76	106	--	--	--	--	24,000	11,000	--
BFT-556	E	02-23-77	35	--	--	--	--	2,200	560	2.3
BFT-562	E	11-24-75	120	--	--	--	--	20,000	6,600	0.7
BFT-563	E	11-25-75	100	--	--	--	--	350	25	1.0
BFT-565	E	11-25-75	170	--	--	--	--	8,000	1,400	0.4
BFT-569	E	11-25-75	70	--	--	--	--	7,500	4,500	0.2
BFT-786	E	01-14-77	524	--	--	--	--	1,700	350	1.2
BFT-787	E	01-14-77	239	--	--	--	--	600	67	0.3
BFT-825	E	02-23-77	150	--	--	--	--	220	5.7	0.3
HAM-73	E	02-23-77	200	--	--	--	--	260	3.7	0.1
HAM-77	E	02-23-77	153	--	--	--	--	--	46	0.2
HAM-80	E	01-14-77	60	--	--	--	--	--	5.4	0.2
JAS-101	E	10-11-56	450	--	--	--	--	305	4.0	0.1

Table 2.- Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Solids, dissolved (mg/L)	Hardness, total (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Non-car- bonate hardness (mg/L)	Sulfate, dissolved (mg/L)	Calcium, dis- solved (mg/L)	Iron, total (mg/L)
BFT-121	E	01-14-77	139	120	135	--	7	1.3	45	--
BFT-458	E	10-21-74	202	90	178	--	0	2.4	23	--
BFT-459	E	11-15-76	20,000	4,500	396	--	4,100	1,400	480	--
BFT-556	E	02-23-77	1,562	60	410	--	0	40	9	--
BFT-562	E	11-24-75	10,700	3,100	92	--	3,000	69	340	--
BFT-563	E	11-25-75	219	150	172	--	7	4.0	50	--
BFT-565	E	11-25-75	2,650	900	197	--	730	110	250	--
BFT-569	E	11-25-75	7,800	3,000	171	--	2,800	430	840	--
BFT-786	E	01-14-77	867	110	192	--	0	59	19	--
BFT-787	E	01-14-77	341	240	237	--	46	4.2	83	--
BFT-825	E	02-23-77	254	110	150	--	0	7.3	30	--
HAM-73	E	02-23-77	250	130	160	--	3	4.4	48	--
HAM-77	E	02-23-77	316	170	140	--	55	2.0	56	--
HAM-80	E	01-14-77	167	80	106	--	0	7.2	29	--
JAS-101	E	10-11-56	200	141	188	--	--	3.6	43	--

Table 2.-Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1917-1977--Continued

[μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; Tr, trace; ° C, degrees Celsius;
USMCRD, United States Marine Corps Recruit Depot; --, no data]

Well number	Source ¹	Date	Iron, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Nitrate, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium plus potassium, dissolved (mg/L)
BFT-121	E	01-14-77	0.04	1.4	0.7	--	12	5	--
BFT-458	E	10-21-74	0.00	7.8	6.2	0.01	43	26	--
BFT-459	E	11-15-76	0.23	790	300	0.02	18	6,000	--
BFT-556	E	02-23-77	0.02	8.9	22	0.00	30	480	--
BFT-562	E	11-24-75	3.2	540	120	0.04	52	2,000	--
BFT-563	E	11-25-75	6.6	5.6	2.4	0.01	21	18	--
BFT-565	E	11-25-75	0.02	66	6.0	0.04	31	690	--
BFT-569	E	11-25-75	0.06	210	18	0.01	17	1,700	--
BFT-786	E	01-14-77	0.08	14	27	--	22	280	--
BFT-787	E	01-14-77	0.01	8	2.0	--	28	32	--
BFT-825	E	02-23-77	0.02	9.7	3.0	0.01	38	10	--
HAM-73	E	02-23-77	0.61	2.7	2.4	0.03	24	5	--
HAM-77	E	02-23-77	0.83	8.1	4.0	0.01	49	10	--

¹ A, from Cooke, 1936; B, from Counts, 1960; C, from Siple, 1960; D, from Back and others, 1970; and E, from Hayes, 1979

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984

[°C, degrees Celsius;mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Depth of well (feet)	Temperature (°C)	pH (standard units)	Alkalinity (mg/L as CaCO ₃)	Specific conductance (µS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Solids, dissolved (mg/L)
BFT-1604	02-21-84	105	19.0	7.90	142.0	460	80.3	1.52	422
BFT-506	04-11-84	75	18.0	7.49	23.0	170	22.7	0.00	84
BFT-562	03-22-84	82	20.0	6.73	137.0	20,000	6,308.0	0.54	13,710
BFT-472	04-11-84	99	18.5	8.20	217.0	575	67.5	0.33	335
BFT-452	03-22-84	78	20.0	9.04	318.0	37,000	13,210.0	0.42	29,096
BFT-455	03-22-84	98	20.0	7.52	220.0	16,000	4,839.0	0.71	11,732
BFT-456	04-11-84	75	20.0	7.67	85.6	19,000	7,373.0	0.68	13,107
BFT-1458	04-11-84	45	14.5	8.08	193.0	750	144.0	0.22	615
BFT-1459	04-11-84	63	17.0	8.25	55.0	725	61.0	0.48	436
BFT-1560	04-11-84	52	16.0	8.24	111.0	400	39.0	0.19	270
BFT-1537	01-24-84	70	18.0	7.63	152.0	990	217.9	0.24	656
BFT-488	04-11-84	100	19.0	8.23	223.0	500	44.9	0.35	430
BFT-1260	03-22-84	92	20.0	8.20	173.0	340	18.2	0.37	281
BFT-1253	01-24-84	70	17.5	7.45	181.0	320	17.0	0.29	261
BFT-1615	04-11-84	65	17.6	8.33	179.0	342	16.5	0.44	211
BFT-599	01-24-84	100	16.0	8.12	261.0	410	20.5	0.24	303
BFT-159	01-24-84	50	19.0	7.90	77.0	195	9.0	0.33	112

Table 3--Historical water-chemistry analyses for wells open to the upper permeable zone of the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984

Well number	Date	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Sulfide, dissolved (mg/L)	[°C, degrees Celsius;mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]		Calcium, total (mg/L)	Calcium, dissolved (mg/L)	Iron, total (µg/L)	Iron, dissolved (µg/L)	Magnesium, total (mg/L)	Magnesium, dissolved (mg/L)
BFT-1604	02-21-84	137	6.2	1.23	32.2	29.7	69	38	13.75	13.66		
BFT-506	04-11-84	21	18.5	0.00	8.5	8.0	844	831	2.69	2.51		
BFT-562	03-22-84	3,863	63.9	17.20	731.0	468.0	2,380	428	495.00	490.00		
BFT-472	04-11-84	205	3.8	0.00	82.3	79.6	429	203	6.90	6.80		
BFT-452	03-22-84	3,808	36.7	12.95	21.6	18.7	25,400	326	912.00	876.00		
BFT-455	03-22-84	2,689	170.0	0.68	355.0	332.0	6,630	560	438.00	431.00		
BFT-456	04-11-84	860	209.0	12.00	344.5	333.1	61,100	561	320.00	310.00		
BFT-1458	04-11-84	287	4.8	0.00	115.0	66.8	1,308	4	6.60	6.10		
BFT-1459	04-11-84	235	7.3	0.10	94.1	41.7	811	23	5.90	2.37		
BFT-1560	04-11-84	135	40.8	0.00	54.0	45.9	1,388	109	2.46	2.30		
BFT-1537	01-24-84	485	21.2	0.22	175.0	77.8	3,970	27	11.72	8.15		
BFT-488	04-11-84	189	4.1	0.00	75.5	73.3	522	499	5.50	5.50		
BFT-1260	03-22-84	185	4.3	0.00	65.5	58.3	2,850	650	5.30	4.70		
BFT-1253	01-24-84	158	3.3	0.00	57.3	54.8	535	504	3.72	3.71		
BFT-1615	04-11-84	156	3.6	0.00	62.4	59.1	11	0	5.00	4.80		
BFT-599	01-24-84	509	7.2	0.00	195.0	72.6	1,140	250	5.46	4.20		
BFT-159	01-24-84	74	4.1	0.02	27.2	26.3	278	241	1.50	1.47		

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Depth of well (feet)	Temperature (°C)	pH (standard units)	Alkalinity (mg/L as CaCO ₃)	Specific conductance (µS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Solids, dissolved (mg/L)
BFT-1514	01-24-84	90	18.7	7.65	125.0	250	14.0	0.15	282
BFT-510	04-11-84	60	20.0	8.43	247.0	650	74.0	0.65	505
BFT-519	04-11-84	60	18.0	8.12	183.0	385	17.5	0.18	320
BFT-1549	03-22-84	81	21.0	9.62	30.0	175	16.3	0.31	74
BFT-1616	04-11-84	75	19.0	8.00	191.0	420	21.0	0.20	356
BFT-1421	01-24-84	90	17.3	7.22	222.0	490	50.0	0.21	478
BFT-549	04-11-84	30	19.0	8.04	142.0	370	39.5	0.17	204
BFT-1491	04-11-84	50	--	--	--	--	--	--	--
BFT-782	01-11-84	90	17.3	7.60	155.0	295	16.8	0.21	237
BFT-1603	02-21-84	43	18.5	7.31	135.0	1,040	378.7	0.20	1,037
BFT-1619	04-11-84	70	17.0	8.38	131.0	390	59.0	0.12	340
BFT-591	04-11-84	60	18.5	7.98	95.0	192	9.5	0.15	190
BFT-1598	03-22-84	65	19.0	8.30	135.0	260	7.5	0.18	149
BFT-1584	01-11-84	130	13.0	7.60	140.0	220	11.5	0.18	225
BFT-1593	01-24-84	70	15.5	7.20	112.0	2,000	690.0	0.12	1,495
BFT-1498	01-11-84	45	15.0	--	--	275	--	--	--
BFT-468	04-11-84	63	18.0	8.32	176.0	340	17.5	0.40	212
BFT-1582	01-11-84	80	18.3	8.00	136.0	255	12.0	0.10	236
BFT-1270	01-11-84	70	16.5	7.60	164.0	275	12.5	0.12	311

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued
[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Sulfide, dissolved (mg/L)	Calcium, total (mg/L)	Calcium, dissolved (mg/L)	Iron, total (µg/L)	Iron, dissolved (µg/L)	Magnesium, total (mg/L)	Magnesium, dissolved (mg/L)
BFT-1514	01-24-84	124	3.5	0.00	46.4	43.4	197	91	2.02	2.01
BFT-510	04-11-84	198	3.8	0.00	79.4	71.5	377	333	11.70	11.20
BFT-519	04-11-84	194	0.0	0.00	77.6	74.2	32	18	11.60	11.40
BFT-1549	03-22-84	57	4.8	0.00	20.6	18.5	20	12	1.40	1.30
BFT-1616	04-11-84	205	3.8	0.00	82.0	64.2	2,098	618	4.20	3.70
BFT-1421	01-24-84	286	4.9	0.02	100.0	71.7	1,320	375	8.85	8.07
BFT-549	04-11-84	140	5.4	0.00	56.0	54.8	670	367	2.76	2.75
BFT-1491	04-11-84	--	--	0.00	--	--	--	--	--	--
BFT-782	01-11-84	196	4.0	0.50	73.9	54.9	1,047	761	3.00	2.70
BFT-1603	02-21-84	350	42.4	0.02	118.2	118.0	8,720	7,710	13.41	13.30
BFT-1619	04-11-84	133	8.3	0.00	53.2	51.2	484	384	4.28	4.18
BFT-591	04-11-84	88	3.8	0.00	35.2	34.0	1,081	898	1.77	1.73
BFT-1598	03-22-84	142	3.7	0.00	52.0	51.4	570	492	2.90	2.80
BFT-1584	01-11-84	142	3.3	0.02	52.5	49.9	405	277	2.70	2.60
BFT-1593	01-24-84	579	57.8	0.03	193.0	191.0	3,340	1,960	23.70	22.50
BFT-1498	01-11-84	--	--	0.00	--	--	--	--	--	--
BFT-468	04-11-84	198	4.5	0.00	79.4	63.9	1,276	792	3.80	3.40
BFT-1582	01-11-84	143	--	0.00	53.2	51.7	52	40	2.50	2.40
BFT-1270	01-11-84	143	3.3	0.00	53.2	51.4	308	294	2.50	2.40

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Depth of well (feet)	Temperature (°C)	pH (standard units)	Alkalinity (mg/L as CaCO ₃)	Specific conductance (µS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Solids, dissolved (mg/L)
BFT-1580	01-11-84	50	19.0	7.70	145.0	260	8.2	0.10	231
BFT-1581	01-11-84	63	17.5	7.70	190.0	318	13.9	0.10	325
BFT-1618	04-11-84	45	13.0	7.75	387.0	9,800	4,308.0	0.22	9,021
BFT-1578	01-11-84	70	19.0	7.70	176.0	277	12.0	0.13	282
BFT-1497	04-24-84	90	17.0	8.40	--	209	--	--	--
BFT-1579	01-11-84	100	18.0	7.60	140.0	250	11.5	0.16	227
BFT-1488	01-24-84	80	16.0	--	--	235	--	--	--
BFT-1617	04-11-84	45	19.0	8.43	55.0	380	50.0	0.25	312
BFT-1404	03-22-84	40	18.0	7.65	143.0	295	15.3	0.21	341
BFT-1520	03-22-84	50	20.5	7.68	171.0	1,650	395.0	0.35	1,130
BFT-1614	04-11-84	70	20.0	8.18	192.0	800	165.9	0.25	620
BFT-470	03-22-84	62	19.5	7.93	208.0	370	16.3	0.27	313
BFT-1594	01-24-84	100	14.0	7.50	140.0	440	68.0	0.18	382
BFT-1504	04-11-84	50	17.0	8.20	102.0	900	173.9	0.12	701
BFT-1610	02-21-84	57	19.0	8.27	252.0	250	22.6	0.26	259
BFT-1610	02-21-84	63	19.8	--	--	263	23.1	--	--
BFT-1610	02-21-84	66	19.0	--	--	320	27.4	--	--
BFT-1610	02-21-84	66	17.5	--	--	348	33.2	--	--
BFT-1587	03-22-84	85	20.0	8.06	172.0	465	77.3	0.25	852

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued
[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Sulfide, dissolved (mg/L)	Calcium, total (mg/L)	Calcium, dissolved (mg/L)	Iron, total (µg/L)	Iron, dissolved (µg/L)	Magnesium, total (mg/L)	Magnesium, dissolved (mg/L)
BFT-1580	01-11-84	151	5.3	0.02	54.2	51.7	595	562	3.90	3.80
BFT-1581	01-11-84	206	3.3	0.00	78.2	69.7	75	73	2.60	2.50
BFT-1618	04-11-84	1,126	23.9	0.00	451.0	392.0	4,680	411	197.00	184.00
BFT-1578	01-11-84	180	3.1	0.00	66.9	63.7	391	350	3.20	3.10
BFT-1497	04-24-84	--	--	0.00	--	--	--	--	--	--
BFT-1579	01-11-84	139	3.3	0.00	52.5	52.1	551	467	2.00	1.90
BFT-1488	01-24-84	--	--	0.09	--	--	--	--	--	--
BFT-1617	04-11-84	123	35.9	0.00	49.4	48.2	53	36	3.05	3.02
BFT-1404	03-22-84	133	13.4	7.10	47.7	44.5	36,400	851	3.40	2.80
BFT-1520	03-22-84	339	37.8	2.10	85.5	84.7	82	29	30.60	29.80
BFT-1614	04-11-84	171	12.3	2.60	68.3	64.7	1,875	859	15.20	14.10
BFT-470	03-22-84	210	3.4	0.00	75.3	72.8	1,300	660	5.40	4.70
BFT-1594	01-24-84	158	11.6	0.04	53.0	51.6	230	80	6.27	6.04
BFT-1504	04-11-84	250	12.3	0.00	100.5	98.8	673	211	13.80	13.20
BFT-1610	02-21-84	123	6.7	0.00	41.1	40.8	480	22	3.74	3.65
BFT-1610	02-21-84	--	--	0.00	--	--	--	--	--	--
BFT-1610	02-21-84	--	--	0.00	--	--	--	--	--	--
BFT-1610	02-21-84	--	--	0.00	--	--	--	--	--	--
BFT-1587	03-22-84	311	7.1	0.15	103.6	70.6	181	0	12.80	4.90

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Depth of well (feet)	Temperature (°C)	pH (standard units)	Alkalinity (mg/L as CaCO ₃)	Specific conductance (µS/cm)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Solids, dissolved (mg/L)
BFT-1612	04-11-84	75	20.0	8.22	161.0	430	49.0	0.18	380
BFT-966	03-26-84	91	19.0	7.89	220.0	850	147.0	0.22	564
BFT-1557	03-22-84	75	20.5	8.03	213.0	400	19.0	0.31	306
BFT-1613	04-11-84	70	18.0	8.32	174.0	405	22.0	0.26	303
BFT-970	03-26-84	159	17.0	7.96	215.0	390	18.6	0.32	284
BFT-1428	03-22-84	82	20.0	7.99	183.0	342	23.4	0.22	306
BFT-989	04-11-84	91	18.0	8.59	226.0	470	31.0	0.22	356
BFT-969	03-26-84	105	16.0	7.82	226.0	455	28.6	0.24	306
BFT-1288	03-22-84	94	20.0	8.08	177.0	364	18.2	0.32	299
BFT-534	03-22-84	110	19.0	8.16	176.0	350	20.2	0.15	386
BFT-530	03-26-84	190	16.0	7.94	220.0	720	126.9	0.33	521
BFT-430	03-22-84	92	21.0	8.20	18.0	6,200	2,218.0	0.10	5,125
BFT-1043	01-24-84	99	16.0	7.62	95.0	345	63.0	0.12	338
BFT-569	04-11-84	40	16.5	8.05	140.0	6,900	2,524.0	0.11	5,098
BFT-1509	01-24-84	200	8.9	7.60	97.0	182	19.0	0.09	208
BFT-1545	01-11-84	60	11.0	7.60	114.0	600	122.0	0.14	490

Table 3.--Historical water-chemistry analyses for wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C., 1984--Continued
[°C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; --, no data]

Well number	Date	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Sulfide, dissolved (mg/L)	Calcium, total (mg/L)	Calcium, dissolved (mg/L)	Iron, total (µg/L)	Iron, dissolved (µg/L)	Magnesium, total (mg/L)	Magnesium, dissolved (mg/L)
BFT-1612	04-11-84	165	4.7	0.00	66.0	63.8	90	69	4.20	4.10
BFT-966	03-26-84	295	13.9	0.74	95.9	94.1	72	70	13.40	13.20
BFT-1557	03-22-84	245	4.3	0.00	85.1	67.7	435	48	7.90	6.70
BFT-1613	04-11-84	162	4.0	0.00	64.9	63.9	71	35	4.00	4.00
BFT-970	03-26-84	217	4.4	0.00	80.4	80.2	1,240	1,170	4.00	3.80
BFT-1428	03-22-84	190	6.4	0.40	64.4	62.8	602	430	7.00	6.60
BFT-989	04-11-84	220	4.6	0.00	88.2	85.3	1,976	1,071	4.90	4.10
BFT-969	03-26-84	235	4.8	0.00	84.5	81.3	2,390	1,010	5.90	5.80
BFT-1288	03-22-84	229	4.4	0.10	57.6	52.7	628	0	20.70	11.80
BFT-534	03-22-84	176	3.7	0.00	62.0	58.9	244	117	5.20	4.80
BFT-530	03-26-84	294	3.7	0.00	102.9	101.5	311	225	8.90	8.10
BFT-430	03-22-84	1,030	288.0	0.68	232.0	213.0	52,500	252	109.50	103.90
BFT-1043	01-24-84	142	11.1	0.00	43.1	35.5	63	59	5.45	5.44
BFT-569	04-11-84	1,131	16.3	0.00	454.0	421.0	114,700	14,370	94.00	93.00
BFT-1509	01-24-84	104	10.9	0.00	38.2	34.2	103	22	1.97	1.95
BFT-1545	01-11-84	246	3.1	0.00	82.6	76.1	240	50	9.60	8.70

Note: All data from Hassan, 1985

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹ .	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
BFT-22	A	05-05-43	84	--	--	14	--	216	12	1.6	238
BFT-26	A	04-05-44	117	--	--	9	--	144	1	--	183
BFT-29	A	04-17-44	87	--	--	18	--	123	4	--	118
BFT-40	A	04-11-44	50	--	--	53	--	159	1	--	168
BFT-52	A	04-12-44	240	--	--	8	--	126	1	--	148
BFT-64	A	04-17-44	90	--	--	645	--	342	36	--	224
BFT-66	A	04-21-44	166	--	--	10	--	142	1	--	171
BFT-75	A	04-21-44	370	--	--	7	--	129	2	--	187

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.--Continued

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹ .	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
Red Bluff, 1	B	07-07-43	420	--	--	5.0	--	--	--	--	--
N. side, State Hwy 6 at Bluffton, 10	B	07-07-43	--	58	130	3.9	--	--	--	--	--
Prichard Station, 18	B	07-07-43	--	196	232	3.8	--	--	--	--	--
Daufuskie Island, 531	B	06-06-41	132	--	--	7.6	--	--	--	--	--
Jenkins Dock, Jenkins Island, 62	B	08-21-41	100	--	--	24	--	--	--	--	--
Hilton Head Island, 63	B	08-21-41	129	--	--	28	--	--	--	--	--
Camp McDougall, 66	B	08-21-41	148	--	--	54	--	--	--	--	--
Hilton Head Island		10-23-42	148	--	--	59	--	--	--	--	--
Buckingham Ferry, 75	B	08-20-42	--	60	90	20	--	--	--	--	--
		07-09-43	--	60	90	20	--	--	--	--	--
Jasper Co., .7 mile east of SC/GA line, 300ft N.W. of Hwy 17, 1	B	08-19-42	--	204	503	5.4	--	--	--	--	--
		07-09-43	--	--	--	5.1	--	--	--	--	--
Jasper Co., W. of Screvens Ferry Rd., Red Bluff Rd., 5	B	08-19-42	300	--	--	6.1	--	--	--	--	--
		07-09-43	--	--	--	5.9	--	--	--	--	--

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.--Continued

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
BFT-1 (Officer's Mess)	C	--	84	--	--	4,900	--	--	--	--	--
BFT-2 (Power-House)	C	--	315	--	--	3,000	--	--	--	--	--
BFT-3	C	--	112	--	--	1,350	--	--	--	--	--
BFT-4 (Well 7)	C	--	112	--	--	3,000	--	--	--	--	--
BFT-5 (Well 7a)	C	--	112	--	--	3,000	--	--	--	--	--
BFT-7 (Rifle Range)	C	--	134	--	--	1,500	--	--	--	--	--
BFT-8 (Rifle Range)	C	--	90	--	--	1,100	--	--	--	--	--
BFT-13 (Incinerator, Horse Island)	C	--	66	--	--	9,640	--	--	--	--	--
BFT-9 (Rifle Island)	C	--	100	--	--	5,920	--	--	--	--	--
BFT- 24,33,19, and 21	C	05-05-43	--	90	190	20	--	--	--	--	--
BFT-45 (East Ice Co.)	C	04-11-44	50	--	--	53	--	--	--	--	--

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.--Continued

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹ .	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
BFT-3	D	--	112	--	--	2,640	--	--	--	--	--
BFT-52	D	--	240	--	--	12	--	--	--	--	--
BFT-92	D	--	--	--	--	8	--	--	--	--	--
BFT-94	D	--	--	--	--	11	--	--	--	--	--
BFT-100	D	--	200	--	--	8	--	--	--	--	--
BFT-103	D	--	100	--	--	10	--	--	--	--	--
BFT-181	D	--	115	--	--	1,440	--	--	--	--	--
BFT-203	D	--	--	--	--	66	--	--	--	--	--
BFT-207	D	--	100	--	--	13	--	--	--	--	--
BFT-213	D	--	--	--	--	10	--	--	--	--	--
BFT-235	D	--	171	--	--	11	--	--	--	--	--
BFT-236	D	--	200	--	--	37	--	--	--	--	--
BFT-239	D	--	--	--	--	11	--	--	--	--	--
BFT-245	D	--	--	--	--	12	--	--	--	--	--

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.--Continued

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹ .	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
BFT-260	D	--	--	--	--	12	--	--	--	--	--
BFT-287	D	--	194	--	--	39	--	--	--	--	--
BFT-304	D	--	746	--	--	11	--	--	--	--	--
BFT-306	D	--	71	--	--	14	--	--	--	--	--
BFT-311	D	--	142	--	--	10	--	--	--	--	--
BFT-312	D	--	165	--	--	11	--	--	--	--	--
BFT-314	D	--	230	--	--	12	--	--	--	--	--
BFT-317	D	--	196	--	--	39	--	--	--	--	--
BFT-319	D	--	--	--	--	34	--	--	--	--	--
BFT-320	D	--	164	--	--	10	--	--	--	--	--
BFT-322	D	--	240	--	--	20	--	--	--	--	--
BFT-324	D	--	220	--	--	70	--	--	--	--	--
BFT-336	D	--	--	--	--	15	--	--	--	--	--

Table 4.--Historical analyses for selected wells open to the Upper Floridan aquifer in the Port Royal Sound area, S.C.--Continued

[mg/L, milligrams per liter; --, no data]

Well number	Source ¹	Date	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L)	Sulfate, dissolved (mg/L)	Iron, dissolved (mg/L)	Bicarbonate (mg/L)
BFT-339	D	--	--	--	--	11	--	--	--	--	--
BFT-340	D	--	--	--	--	17	--	--	--	--	--
BFT-341	D	--	100	--	--	13	--	--	--	--	--
BFT-338	D	--	--	--	--	13	--	--	--	--	--
BFT-407	D	--	214	--	--	120	--	--	--	--	--

¹. A, from Mundorff, 1944; B, from Warren, 1944; C, from Siple, 1946; D, from McCollum, 1964.

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87

Well number (figs. 1, 5)	Date	Elevation of land surface above sea level (feet)	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Water temperature (°C)	[°C, degrees Celsius, µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]	
							Specific conductance (µS/cm)	
BFT-121	02-27-85	31.2	105.00	84	100	20	241	
	02-27-85	31.2				20	241	
	12-17-85	31.2				20	261	
BFT-181	12-20-84	11.2	119.00	93	117	20.5	4,760	
	12-20-84	11.2				20.5	4,760	
BFT-210	05-21-85	5.9	164.00	130	160	20.5	325	
	05-21-85	5.9				20.5	325	
	05-20-86	5.9				20.5	282	
BFT-439	07-23-85	6.9	195	182	195	21.5	332	
	07-23-85	6.9				21.5	332	
BFT-441	01-10-85	10.1	216	187	216	21	500	
	01-10-85	10.1				21	500	
BFT-453	04-16-85	18	105	85	105	21.5	289	
	04-16-85	18				21.5	289	
	06-04-86	18				22	303	
BFT-459	02-26-85	10.2	100	85	100	20.5	4,020	
	02-26-85	10.2				20.5	4,020	
BFT-565	05-22-85	15.8	207	89	207	21.5	11,900	
	05-22-85	15.8				21.5	11,900	
BFT-566	02-25-85	13.1	189	184	232	21.5	42,800	
	02-25-85	13.1				21.5	42,800	
BFT-787	04-23-85	12	185	126	239	21	479	
	04-23-85	12				21	479	

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

Well number (figs. 1, 5)	Date	Specific con- ductance, lab ($\mu\text{S}/\text{cm}$)	Dissolved oxygen (mg/L)	pH (standard units)	pH lab (standard units)	[$^{\circ}\text{C}$, degrees Celsius, $\mu\text{S}/\text{cm}$, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; $\mu\text{g}/\text{L}$, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]	
						Dissolved residue 105°C (mg/L)	Dissolved residue 180°C (mg/L)
BFT-121	02-27-85	239	--	7.60	7.30	--	--
	02-27-85	--	--	7.60	7.30	--	--
	12-17-85	--	--	7.69	--	--	--
BFT-181	12-20-84	--	0.1	7.20	--	--	--
	12-20-84	--	0.1	7.20	7.13	2,960	--
BFT-210	05-21-85	275	<0.1	7.50	7.70	--	--
	05-21-85	--	<0.1	7.50	8.09	185	--
	05-20-86	--	0	8.17	--	--	--
BFT-439	07-23-85	337	0	7.9	7.8	--	--
	07-23-85	--	0	7.9	8.05	241	--
BFT-441	01-10-85	--	.2	7.4	--	--	--
	01-10-85	--	.2	7.4	7.39	327	--
BFT-453	04-16-85	303	--	7.1	7.5	--	--
	04-16-85	--	--	7.1	8.04	324	--
	06-04-86	314	.2	7.78	7.7	--	--
BFT-459	02-26-85	4,190	.4	7.1	7.1	--	--
	02-26-85	4,060	--	7.1	7.46	2,460	--
BFT-565	05-22-85	13,900	0	6.8	6.9	--	--
	05-22-85	12,000	0	6.8	8.16	27,850	--
BFT-566	02-25-85	39,900	.7	6.6	6.6	--	--
	02-25-85	43,100	.7	6.6	6.93	27,850	--
BFT-787	04-23-85	511	--	7.3	7.7	--	--
	04-23-85	--	--	7.3	7.95	1,440	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

Well number (figs. 1, 5)	Date	[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]					
		Alkalinity, lab (mg/L as CaCO ₃)	Alkalinity, carbonate (mg/L as CaCO ₃)	Bicarbonate (mg/L as HCO ₃)	Density (gm/mL at 20 °C)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)
BFT-121	02-27-85	--	114	139	.99	--	.01
	02-27-85	128	114	139	--	--	--
	12-17-85	--	124	151	--	.062	<.011
BFT-181	12-20-84	--	206	251	1.001	.928	--
	12-20-84	207	206	251	--	--	--
BFT-210	05-21-85	--	111	135	.999	<.01	<.0001
	05-21-85	120	111	135	--	--	--
	05-20-86	--	112	137	--	--	--
BFT-439	07-23-85	--	114	139	.999	.085	<.01
	07-23-85	115	114	139	--	--	.01
BFT-441	01-10-85	--	197	240	.999	.182	<.01
	01-10-85	229	197	240	--	--	--
BFT-453	04-16-85	--	149	182	.999	.309	<.01
	04-16-85	219	149	182	--	--	--
	06-04-86	153	154	188	--	--	--
BFT-459	02-26-85	--	180	219	1.001	--	<.01
	02-26-85	147	180	219	--	--	--
BFT-565	05-22-85	--	277	338	1.006	1.1	.02
	05-22-85	257	277	338	--	--	--
BFT-566	02-25-85	--	501	611	1.019	--	.01
	02-25-85	489	501	611	--	--	--
BFT-787	04-23-85	--	222	271	.999	.314	<.01
	04-23-85	180	222	271	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nitrogen, NO ₂ +NO ₃ , dissolved (mg/L as N)	Phosphorous, dissolved (mg/L)	Phosphorous, ortho, dissolved (mg/L as P)	Carbon, organic, total (mg/L)	Carbon, organic, dissolved (mg/L)	Sulfide, dissolved (mg/L)
BFT-121	02-27-85	<.100	.200	.020	--	2.0	--
	02-27-85	--	--	--	--	--	0.0
	12-17-85	<.100	.080	.020	--	--	--
BFT-181	12-20-84	.018	--	<.01	--	4.3	--
	12-20-84	--	--	--	--	--	.3
BFT-210	05-21-85	<.010	<.010	0.020	--	1.3	--
	05-21-85	--	--	--	--	--	0
	05-20-86	--	--	--	--	--	--
BFT-439	07-23-85	<.010	<.01	<.01	--	3.9	--
	07-23-85	--	--	--	--	--	0.0
BFT-441	01-10-85	<.010	.03	<.01	3.0	--	--
	01-10-85	--	--	--	--	--	.6
BFT-453	04-16-85	<.010	<.01	<.01	--	3	--
	04-16-85	--	--	--	--	--	.1
	06-04-86	--	--	--	--	--	--
BFT-459	02-26-85	<.010	<.040	.020	--	2.7	--
	02-26-85	--	--	--	--	--	.03
BFT-565	05-22-85	<.1	0.020	.050	--	2.6	--
	05-22-85	--	--	--	--	--	3.2
BFT-566	02-25-85	<.01	1.40	1.40	--	5.2	--
	02-25-85	--	--	--	--	--	25
BFT-787	04-23-85	<.010	0.100	0.070	--	3.2	--
	04-23-85	--	--	--	--	--	0.0

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
BFT-121	02-27-85	--	--	--	--	--	--
	02-27-85	43	2.2	5.2	.67	5.7	3.2
	12-17-85	--	--	--	--	--	--
BFT-181	12-20-84	--	--	--	--	--	--
	12-20-84	140	41	680	10	1,400	95
BFT-210	05-21-85	--	--	--	--	--	--
	05-21-85	27	10	22	1.6	17	9.2
	05-20-86	--	--	--	--	--	--
BFT-439	07-23-85	--	--	--	--	29	--
	07-23-85	32.0	8.7	34	3.2	49	17
BFT-441	01-10-85	--	--	--	--	--	--
	01-10-85	62	16	30	3.0	43	7.3
BFT-453	04-16-85	--	--	--	--	--	--
	04-16-85	85	3.9	21	1	38	3.4
	06-04-86	32	7.8	21	3.8	6.6	2.7
BFT-459	02-26-85	--	--	--	--	--	--
	02-26-85	270	32	600	5.9	1,200	36
BFT-565	05-22-85	--	--	--	--	4,600	--
	05-22-85	390	280	2,400	53	4,600	560
BFT-566	02-25-85	--	--	--	--	--	--
	02-25-85	450	1,100	8,300	280	15,000	1,600
BFT-787	04-23-85	--	--	--	--	--	--
	04-23-85	96	7.8	34	.11	63	83

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Boron, dissolved (µg/L)	Iron, dissolved (µg/L)	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)
BFT-121	02-27-85	--	12	<20	--	--	--
	02-27-85	.17	11	--	2,200	38	--
	12-17-85	--	--	--	--	--	--
BFT-181	12-20-84	--	40	160	--	--	<1
	12-20-84	.32	44	--	2,000	82	--
BFT-210	05-21-85	--	--	40	--	--	2
	05-21-85	.53	43	--	66	41	--
	05-20-86	--	--	--	--	--	--
BFT-439	07-23-85	--	45	70	--	--	2
	07-23-85	.49	42	--	20	0	--
BFT-441	01-10-85	--	36	50	--	--	<1
	01-10-85	.36	36	--	48	0	--
BFT-453	04-16-85	--	34	60	--	--	45
	04-16-85	.17	21	--	360	15	--
	06-04-86	.50	32	60	--	--	--
BFT-459	02-26-85	--	36	120	--	--	<1
	02-26-85	.20	36	--	140	45	--
BFT-565	05-22-85	--	30	820	--	--	1
	05-22-85	.35	28	--	140	14	--
BFT-566	02-25-85	--	25	3,200	--	--	<1
	02-25-85	.18	30	--	200	330	--
BFT-787	04-23-85	--	28	40	--	--	1
	04-23-85	.18	26	--	330	21	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; μ g/L, micrograms per liter; gm/mL, grams per milliliter; ml, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nickel, dissolved (μ g/L)	Strontium, dissolved (μ g/L)	Vanadium, dissolved (μ g/L)	Antimony, dissolved (μ g/L)	Aluminum, dissolved (μ g/L)	Lithium, dissolved (μ g/L)
BFT-121	02-27-85	--	--	<1	--	--	--
	02-27-85	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--
BFT-181	12-20-84	1	--	--	<1	20	30
	12-20-84	--	--	--	--	--	--
BFT-210	05-21-85	2	--	<1	<1	30	10
	05-21-85	--	500	--	--	--	--
	05-20-86	--	--	--	--	--	--
BFT-439	07-23-85	5	--	<1	<1	20	10
	07-23-85	--	--	--	--	--	--
BFT-441	01-10-85	1	--	<1	<1	20	10
	01-10-85	--	--	--	--	--	--
BFT-453	04-16-85	5	--	<1	4	10	10
	04-16-85	--	--	--	--	--	--
	06-04-86	--	<11	--	--	--	--
	02-26-85	<1	1,500	--	<1	<10	30
BFT-459	02-26-85	--	--	--	--	--	--
	05-22-85	1	--	--	<1	10	70
BFT-565	05-22-85	--	--	--	--	--	--
	02-25-85	<1	4,800	--	<1	10	120
BFT-566	02-25-85	--	--	--	--	--	--
	04-23-85	1	--	<1	<1	20	10
BFT-787	04-23-85	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Tritium, total (T.U.)	¹³ C/ ¹² C Stable isotope ratio (per mil)	² H/H Stable isotope ratio (per mil)	¹⁸ O/ ¹⁶ O Stable isotope ratio (per mil)	¹⁴ C (percent modern)
BFT-121	02-27-85	24	-12.10	-23.4	-4.03	49.0
	02-27-85	--	--	--	--	--
	12-17-85	--	--	--	--	--
BFT-181	12-20-84	3.0	-13.30	-18.9	-3.24	28.3
	12-20-84	--	--	--	--	--
BFT-210	05-21-85	<2.0	-1.80	-17.2	-3.90	2.3
	05-21-85	--	--	--	--	--
	05-20-86	--	--	--	--	--
BFT-439	07-23-85	--	-1.6	-18.9	-3.80	<1.9
	07-23-85	--	--	--	--	--
BFT-441	01-10-85	9.0	-9.5	-18.9	-3.22	22
	01-10-85	--	--	--	--	--
BFT-453	04-16-85	5	-8.6	-15.8	-2.73	.8
	04-16-85	--	--	--	--	--
	06-04-86	--	--	--	--	--
BFT-459	02-26-85	11	-13.9	-16	-3.11	54.7
	02-26-85	--	--	--	--	--
BFT-565	05-22-85	--	-9.6	-6.5	-2.5	13
	05-22-85	--	--	--	--	--
BFT-566	02-25-85	4	-9	3.5	-1.5	74
	02-25-85	--	--	--	--	--
BFT-787	04-23-85	<2.0	-12.20	-19.1	-3.24	39.5
	04-23-85	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Elevation of land surface above sea level (feet)	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Water temperature (°C)	Specific conductance (µS/cm)
BFT-791	03-06-85	10	102	81	102	20	436
	03-06-85					20	436
BFT-795	01-16-85	9.7	91	77	91	21	41,300
	01-16-85					21	40,900
BFT-1288	01-04-95	10	115	60	115	20	408
	01-04-85					20	408
BFT-1672	07-23-84	0	117	95	107	21	1,080
	07-23-84					--	--
	07-25-84		211	174	211	22	24,400
	07-25-84					24	23,500
BFT-1673	08-02-84	0	101	85	101	25	652
	08-02-94					21.5	652
	08-03-84		208	170	208	24	20,000
	08-03-84					23	23,500
BFT-1674	08-09-84	0	113	101	113	25.5	660
	08-09-84					23	705
	08-10-84		174	170	174	22	27,800
	08-10-84					25.5	27,100
BFT-1675	08-24-84	0	103	89	103	21	544
	08-23-84					21	536
	08-24-84		212	186	212	22.3	871
	08-24-84					22.3	838

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Specific con- ductance, lab (µS/cm)	Dissolved oxygen (mg/L)	pH (standard units)	pH lab (standard units)	Dissolved residue, 105 °C (mg/L)	Dissolved residue, 180 °C (mg/L)
BFT-791	03-06-85	443	0	7.4	7.2	--	--
	03-06-85	--	0	7.4	8	368	--
BFT-795	01-16-85	--	.8	7	--	--	--
	01-16-85	41,300	.8	7	6.95	31,500	--
BFT-1288	01-04-95	--	.1	7.5	--	--	--
	01-04-85	415	.1	7.5	7.52	269	--
BFT-1672	07-23-84	1,190	0	7.74	7.7	--	--
	07-23-84	--	0	7.7	8.16	681	--
	07-25-84	25,600	.1	7.01	6.9	--	19,800
	07-25-84	--	.1	7	7.3	--	--
BFT-1673	08-02-84	--	2.5	7.4	8.4	401	--
	08-02-94	898	2.5	7.43	7.4	--	577
	08-03-84	--	.1	7.5	7.79	16,040	--
	08-03-84	23,800	.1	7.33	7.4	--	16,900
BFT-1674	08-09-84	--	0	7.5	8.2	388	--
	08-09-84	690	0.1	7.3	7.4	--	472
	08-10-84	32,400	.1	7.21	7.2	--	22,500
	08-10-84	--	--	7.4	7.8	28,390	--
BFT-1675	08-24-84	707	0	7.71	7.7	--	458
	08-23-84	--	0	7.9	8.2	463	--
	08-24-84	1,110	0	7.26	7.7	--	732
	08-24-84	--	0	8.2	7.9	724	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Alkalinity, lab (mg/L as CaCO ₃)	Alkalinity, carbonate (mg/L as CaCO ₃)	Bicarbonate (mg/L as HCO ₃)	Density (gm/mL at 20 °C)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)
BFT-791	03-06-85	--	196	239	.998	--	--
	03-06-85	214	196	239	--	--	--
BFT-795	01-16-85	--	316	385	1.020	1.7	0.01
	01-16-85	306	316	385	--	--	--
BFT-1288	01-04-95	--	182	222	.997	.364	0.01
	01-04-85	191	182	222	--	--	--
BFT-1672	07-23-84	137	146	178	--	.359	<0.01
	07-23-84	136	--	--	--	--	--
	07-25-84	325	362	441	--	2.6	<0.020
	07-25-84	368	--	--	--	--	--
BFT-1673	08-02-84	165	--	--	--	--	--
	08-02-94	153	157	191	--	.338	<0.01
	08-03-84	122	--	--	--	--	--
	08-03-84	171	176	215	--	1.6	<0.01
BFT-1674	08-09-84	153	--	--	--	--	--
	08-09-84	205	210	256	--	.335	<0.01
	08-10-84	155	160	195	--	1	<0.01
	08-10-84	185	--	--	--	--	--
BFT-1675	08-24-84	126	123	150	0.999	.187	<0.01
	08-23-84	130	--	--	--	--	--
	08-24-84	134	133	162	0.999	.298	<0.01
	08-24-84	130	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nitrogen, NO ₂ +NO ₃ , dissolved (mg/L as N)	Phosphorous, dissolved (mg/L)	Phosphorous, ortho, dissolved (mg/L as P)	Carbon, organic, total (mg/L)	Carbon, organic, dissolved (mg/L)	Sulfide, dissolved (mg/L)
BFT-791	03-06-85	<.01	.05	--	--	3.2	--
	03-06-85	--	--	--	--	--	0.0
BFT-795	01-16-85	.146	1.5	1.5	3.5	--	--
	01-16-85	--	--	--	--	--	14
BFT-1288	01-04-95	<.01	<.01	--	--	3.0	--
	01-04-85	--	--	--	--	--	0.0
BFT-1672	07-23-84	<.01	<.01	.02	--	2.1	--
	07-23-84	--	--	--	--	--	.1
	07-25-84	<.09	<.05	.03	--	4.8	--
	07-25-84	--	--	--	--	--	--
BFT-1673	08-02-84	--	--	--	--	--	.4
	08-02-94	<.01	.01	.05	--	2.0	--
	08-03-84	--	--	--	--	--	.9
	08-03-84	<.01	.01	.04	--	3.0	--
BFT-1674	08-09-84	--	--	--	--	--	.1
	08-09-84	<.01	.05	.07	--	2.3	--
	08-10-84	<.01	.07	.09	--	3.0	--
	08-10-84	--	--	--	--	--	.3
BFT-1675	08-24-84	<.01	<.01	.01	--	3.3	--
	08-23-84	--	--	--	--	--	.1
	08-24-84	<.01	<.01	<.01	--	1.8	--
	08-24-84	--	--	--	--	--	.0

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
BFT-791	03-06-85	-	--	--	--	--	--
	03-06-85	66	12	14	1.5	28	3.2
BFT-795	01-16-85	--	--	--	--	--	--
	01-16-85	320	960	8,400	370	15,000	2,000
BFT-1288	01-04-95	--	--	--	--	--	--
	01-04-85	57	11	13	2.0	22	3.5
BFT-1672	07-23-84	48	14	180	6.3	260	87
	07-23-84	61	13	180	5.2	300	71
	07-25-84	340	640	4,700	140	9,800	1,300
	07-25-84	--	--	--	--	8,200	1,000
BFT-1673	08-02-84	58	25	86	10	190	25
	08-02-94	56	25	82	10	180	41
	08-03-84	310	560	4,100	150	6,400	760
	08-03-84	270	480	3,400	110	8,200	1,100
BFT-1674	08-09-84	73	11	83	4.9	150	11
	08-09-84	70	10	64	4.1	98	15
	08-10-84	380	820	6,500	210	12,000	1,600
	08-10-84	240	850	6,400	280	11,000	1,300
BFT-1675	08-24-84	39	10	94	4.5	110	73
	08-23-84	38	11	110	8.0	100	68
	08-24-84	46	34	180	9.0	160	210
	08-24-84	50	35	160	11	300	190

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; μ g/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Boron, dissolved (μ g/L)	Iron, dissolved (μ g/L)	Manganese, dissolved (μ g/L)	Molybdenum, dissolved (μ g/L)
BFT-791	03-06-85	--	35	50	--	--	<1
	03-06-85	.29	32	--	70	17	--
BFT-795	01-16-85	--	16	3,400	--	--	1
	01-16-85	.17	21	--	200	440	--
BFT-1288	01-04-95	--	34	40	--	--	<1
	01-04-85	.33	31	--	2	11	--
BFT-1672	07-23-84	.70	29	200	44	1	1
	07-23-84	.59	32	--	47	4	--
	07-25-84	.50	26	2,100	240	20	5
	07-25-84	.58	--	--	--	--	--
BFT-1673	08-02-84	.31	37	--	60	22	--
	08-02-94	.50	34	170	82	12	600
	08-03-84	.40	35	--	140	36	--
	08-03-84	.40	29	1,600	200	30	14
BFT-1674	08-09-84	.24	40	--	110	11	--
	08-09-84	.30	39	130	110	11	3
	08-10-84	.30	23	2,600	150	50	6
	08-10-84	.46	24	--	160	62	--
BFT-1675	08-24-84	.70	35	160	47	1	1
	08-23-84	.49	--	--	41	1	--
	08-24-84	1.1	28	250	26	1	1
	08-24-84	.83	30	--	19	0	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Vanadium, dissolved (µg/L)	Antimony, dissolved (µg/L)	Aluminum, dissolved (µg/L)	Lithium, dissolved (µg/L)
BFT-791	03-06-85	2	--	1	<1	20	10
	03-06-85	--	--	--	--	--	--
BFT-795	01-16-85	<1	4,400	--	<1	10	110
	01-16-85	--	--	--	--	--	--
BFT-1288	01-04-95	1	--	<1	<1	20	10
	01-04-85	--	--	--	--	--	--
BFT-1672	07-23-84	<1	420	4	<1	20	14
	07-23-84	--	--	--	--	--	--
	07-25-84	3	4,500	--	<1	20	100
	07-25-84	--	--	--	--	--	--
BFT-1673	08-02-84	--	--	--	--	--	--
	08-02-94	32	1,000	10	16	100	20
	08-03-84	--	--	--	--	--	--
	08-03-84	1	5,300	<6	--	30	100
BFT-1674	08-09-84	--	--	--	--	--	--
	08-09-84	<1	430	--	1	10	20
	08-10-84	2	4,300	--	<1	20	100
	08-10-84	--	--	--	--	--	--
BFT-1675	08-24-84	<1	450	2	<1	30	13
	08-23-84	--	--	--	--	--	--
	08-24-84	<1	2,500	2	<1	50	20
	08-24-84	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Tritium, Total (T.U.)	¹³ C/ ¹² C Stable isotope ratio (per mil)	² H/H Stable isotope ratio (per mil)	¹⁸ O/ ¹⁶ O Stable isotope ratio(per mil)	¹⁴ C (Percent modern)
BFT-791	03-06-85	<2	-11.2	-22.2	-3.99	28
	03-06-85	--	--	--	--	--
BFT-795	01-16-85	14	-8.2	5.3	.68	64.8
	01-16-85	--	--	--	--	--
BFT-1288	01-04-95	<2	-11.4	-22.4	-3.97	37.9
	01-04-85	--	--	--	--	--
BFT-1672	07-23-84	<2	-8.9	-21.6	-3.8	10.5
	07-23-84	--	--	--	--	--
	07-25-84	<2	-7.8	-11.3	-2.3	7.5
	07-25-84	--	--	--	--	--
BFT-1673	08-02-84	--	--	--	--	--
	08-02-94	13	-7.4	-20.7	-3.9	10.6
	08-03-84	--	--	--	--	--
	08-03-84	<2	-6.4	-10.6	-2	10.1
BFT-1674	08-09-84	--	--	--	--	--
	08-09-84	<2	-12	-20.1	-3.6	15
	08-10-84	14	-9	.9	-1.4	18.2
	08-10-84	--	--	--	--	--
BFT-1675	08-24-84	--	-7.7	-21.6	-4	--
	08-23-84	<2	--	--	--	--
	08-24-84	--	-3.7	-21.5	-3.7	2.3
	08-24-84	<2	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; $\mu\text{g}/\text{L}$, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Elevation of land surface above sea level (feet)	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Water temperature (°C)	Specific conductance ($\mu\text{S}/\text{cm}$)
BFT-1676	8-30-84	0	110	97	110	21.5	380
	8-30-84					21.5	354
	8-31-84	0	211	178	182	22	1,640
	8-31-84					22	1,890
BFT-1677	9-07-84	0	99	92	99	21	4,420
	9-07-84					21	4,190
	9-08-84	0	169	159	176	21.5	19,100
	9-08-84					21.5	19,600
BFT-1678	9-20-84	0	87	76	86	21	757
	9-20-84					21	789
	9-21-84		192	151	155	22	1,050
	9-21-84		1			22	1,030
BFT-1679	9-27-84	0	120	108	120	21	1,450
	9-27-84		133		120	21	1,450
BFT-1680	10-05-84	0	117	103	117	21	20,600
	10-05-84					21	19,900
	10-05-84		218	173	218	21.5	25,300
	10-05-84					21.5	24,900
BFT-1689	1-11-85	5	203	91	203	21	246
	1-11-85					21	246
BFT-1754	4-22-85	11	75	66	75	19.5	2,390
	4-22-85					19.5	2,390

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Specific con- ductance, lab (µS/cm)	Dissolved oxygen (mg/L)	pH (standard units)	pH, lab (standard units)	Dissolved residue 105 °C (mg/L)	Dissolved residue 180 °C (mg/L)
BFT-1676	8-30-84	525	0	7.47	7.5	--	312
	8-30-84	--	0	7.8	8.2	319	--
	8-31-84	--	.9	7.3	7.9	1,170	--
	8-31-84	2,660	.9	7.32	7.3	--	1,780
BFT-1677	9-07-84	--	.1	7.6	8.0	2,000	--
	9-07-84	4,500	.1	7.4	7.7	--	2,900
	9-08-84	--	.5	7.5	7.8	13,400	--
	9-08-84	20,300	.5	7.11	7.0	--	13,200
BFT-1678	9-20-84	--	0	7.9	8.2	557	--
	9-20-84	775	0	7.54	7.6	--	458
	9-21-84	882	0	8.34	8.2	--	526
	9-21-84	--	0	8.30	8.3	482	--
BFT-1679	9-27-84	--	0	7.7	8.0	879	--
	9-27-84	1,400	0	7.69	7.7	--	864
BFT-1680	10-05-84	19,700	0	6.99	6.9	--	14,000
	10-05-84	--	0	7.2	7.6	14,200	--
	10-05-84	23,800	.2	6.92	6.8	--	16,400
	10-05-84	--	.2	7.0	7.7	16,560	--
BFT-1689	1-11-85	--	.5	7.9	--	--	--
	1-11-85	--	.5	7.9	7.8	185	--
BFT-1754	4-22-85	2,520	--	7.1	-	--	--
	4-22-85	--	--	7.1	7.13	193	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius, µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; ml, parts per thousand; <, less than]									
Well number (figs. 1, 5)	Date	Alkalinity, lab (mg/L as CaCO ₃)	Alkalinity, carbonate (mg/L as CaCO ₃)	Bicarbonate (mg/L as HCO ₃)	Density (gm/mL at 20 °C)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)		
BFT-1676	8-30-84	173	174	212	1.005	.499	<.01		
	8-30-84	179	--	--	--	--	--		
	8-31-84	125	--	--	--	--	--		
	8-31-84	118	123	150	.999	.714	<.01		
BFT-1677	9-07-84	--	--	--	--	--	--		
	9-07-84	157	169	206	1.001	.989	<.01		
	9-08-84	241	--	--	--	--	--		
	9-08-84	219	248	302	1.008	2	<.01		
BFT-1678	9-20-84	135	--	--	--	--	--		
	9-20-84	128	131	160	1.0	.154	<.010		
	9-21-84	161	167	204	1.001	.030	<.010		
	9-21-84	167	--	--	--	--	--		
BFT-1679	9-27-84	140	--	--	--	--	--		
	9-27-84	137	136	166	1.0	.311	<.010		
BFT-1680	10-05-84	260	274	334	1.010	2.10	<.010		
	10-05-84	253	--	--	--	--	--		
	10-05-84	271	288	351	1.012	2.10	<.010		
	10-05-84	292	--	--	--	--	--		
BFT-1689	1-11-85	--	116	141	1.000	.047	0.040		
	1-11-85	129	116	141	--	--	--		
BFT-1754	4-22-85	--	181	221	.998	.279	<.010		
	4-22-85	151	181	221	--	--	--		

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nitrogen, NO ₂ +NO ₃ , dissolved (mg/L as N)	Phosphorous, dissolved (mg/L)	Phosphorous, ortho, dissolved (mg/L as P)	Carbon, organic, total (mg/L)	Carbon, organic, dissolved (mg/L)	Sulfide, dissolved (mg/L)
BFT-1676	8-30-84	<.01	.02	.02	--	3.0	--
	8-30-84	--	--	--	--	--	0
	8-31-84	--	--	--	--	--	0
	8-31-84	<.01	<.01	<.01	--	1.6	--
BFT-1677	9-07-84	--	--	--	--	--	.4
	9-07-84	<.01	.04	.04	--	1.9	--
	9-08-84	--	--	--	--	--	1.1
	9-08-84	<.01	.07	.06	--	4.0	--
BFT-1678	9-20-84	--	--	--	--	--	0.0
	9-20-84	<.010	0.030	0.040	--	1.1	--
	9-21-84	<.023	0.030	0.030	--	1.3	--
	9-21-84	--	--	--	--	--	0.0
BFT-1679	9-27-84	--	--	--	--	--	0.4
	9-27-84	0.010	0.020	0.010	--	2.2	--
BFT-1680	10-05-84	0.010	0.060	0.070	--	5.2	--
	10-05-84	--	--	--	--	--	1.3
	10-05-84	0.010	0.050	0.070	--	5.0	--
	10-05-84	--	--	--	--	--	0.9
BFT-1689	1-11-85	0.010	0.080	0.060	1.5	--	--
	1-11-85	--	--	--	--	--	0.0
BFT-1754	4-22-85	<.010	0.140	0.140	--	3.5	--
	4-22-85	--	--	--	--	--	0.1

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; ml, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
BFT-1676	8-30-84	57	6.4	40	2	74	1.9
	8-30-84	58	7.3	34	3	54	3.4
	8-31-84	170	45	300	11	720	43
	8-31-84	180	34	370	7.8	760	49
BFT-1677	9-07-84	120	67	680	54	1,400	110
	9-07-84	130	74	630	38	1,400	110
	9-08-84	250	430	3,200	140	6,700	820
	9-08-84	330	430	3,900	110	7,400	720
BFT-1678	9-20-84	41	15	120	7.8	170	13
	9-20-84	42	6.0	100	5.8	150	16
	9-21-84	10	7.5	150	10	150	45
	9-21-84	12	9.4	170	13	140	41
BFT-1679	9-27-84	62	21	240	20	260	190
	9-27-84	57	22	190	12	260	200
BFT-1680	10-05-84	410	480	3,600	130	8,100	800
	10-05-84	320	460	3,500	120	5,900	730
	10-05-84	460	580	4,500	170	9,500	1,000
	10-05-84	370	540	4,400	150	8,300	930
BFT-1689	1-11-85	--	--	--	--	--	--
	1-11-85	27	8.2	11	2.9	3.9	6.9
BFT-1754	4-22-85	--	--	--	--	--	--
	4-22-85	31	8.3	19	1.6	5.8	4.4

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Boron, dissolved (µg/L)	Iron, dissolved (µg/L)	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)
BFT-1676	8-30-84	.40	43	60	20	<10	4
	8-30-84	.38	46	--	30	1	--
	8-31-84	.33	34	--	46	11	--
	8-31-84	.4	31	210	30	10	220
BFT-1677	9-07-84	.68	28	--	93	57	--
	9-07-84	1	25	610	60	40	9
	9-08-84	.56	33	--	160	98	--
	9-08-84	.6	27	1,500	150	120	100
BFT-1678	9-20-84	0.61	32	--	8	32	--
	9-20-84	0.70	28	120	12	19	3
	9-21-84	1.8	19	350	9	4	5
	9-21-84	1.7	22	--	18	15	--
BFT-1679	9-27-84	0.75	27	--	41	4	--
	9-27-84	0.90	26	250	25	<1	<1
BFT-1680	10-05-84	<0.1	19	1,100	290	130	1
	10-05-84	0.19	22	--	230	130	--
	10-05-84	<0.1	21	1,300	90	110	7
	10-05-84	0.19	24	--	92	110	--
BFT-1689	1-11-85	--	36	20	--	--	2
	1-11-85	0.39	35	--	27	29	--
BFT-1754	4-22-85	--	--	170	--	--	4
	4-22-85	0.45	31	--	28	23	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Vanadium, dissolved (µg/L)	Antimony, dissolved (µg/L)	Aluminum, dissolved (µg/L)	Lithium, dissolved (µg/L)
BFT-1676	8-30-84	<1	450	<1	1	<10	10
	8-30-84	--	--	--	--	--	--
	8-31-84	--	--	--	--	--	--
	8-31-84	9	1,500	13	6	10	10
BFT-1677	9-07-84	--	--	--	--	--	--
	9-07-84	1	940	19	<1	20	40
	9-08-84	--	--	--	--	--	--
	9-08-84	15	2,800	58	3	10	90
BFT-1678	9-20-84	--	--	--	--	--	--
	9-20-84	<1	430	2	<1	30	12
	9-21-84	<1	300	<1	<1	40	12
	9-21-84	--	--	--	--	--	--
BFT-1679	9-27-84	--	--	--	--	--	--
	9-27-84	<1	760	4	<1	20	16
BFT-1680	10-05-84	3	3,700	<6	<1	<10	50
	10-05-84	--	--	--	--	--	--
	10-05-84	3	4,600	<6	<1	<10	60
	10-05-84	--	--	--	--	--	--
BFT-1689	1-11-85	<1	--	<1	<1	20	10
	1-11-85	--	--	--	--	--	--
BFT-1754	4-22-85	1	--	--	<1	10	10
	4-22-85	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Tritium, total (T.U.)	¹³ C/ ¹² C Stable isotope ratio (per mil)	² H/H Stable isotope ratio (per mil)	¹⁸ O/ ¹⁶ O Stable isotope ratio (per mil)	¹⁴ C (Percent Modern)
BFT-1676	8-30-84	9	-10.9	-22.5	-3.9	7
	8-30-84	--	--	--	--	--
	8-31-84	--	--	--	--	--
	8-31-84	7	-8.8	-19.8	-3.5	11.8
BFT-1677	9-07-84	--	--	--	--	--
	9-07-84	<2	-7.5	-19.0	-3.2	5
	9-08-84	--	--	--	--	--
	9-08-84	<2	-8.3	-13.3	-2.	6.9
BFT-1678	9-20-84	--	--	--	--	--
	9-20-84	<2.0	-3.12	-21.5	-3.70	--
	9-21-84	6.0	-2.80	-21.5	-3.70	14.2
	9-21-84	--	--	--	--	--
BFT-1679	9-27-84	--	--	--	--	--
	9-27-84	<2.0	-6.60	-22.7	-3.80	--
BFT-1680	10-05-84	3.0	-11.60	-13.9	-2.20	6.0
	10-05-84	--	--	--	--	--
	10-05-84	<2.0	-10.10	-12.5	-1.90	20.0
	10-05-84	--	--	--	--	--
BFT-1689	1-11-85	8.0	-3.30	-17.8	-3.83	1.0
	1-11-85	--	--	--	--	--
BFT-1754	4-22-85	2.0	-14.60	-20.5	-3.81	44.0
	4-22-85	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Elevation of land surface above sea level (feet)	Depth of well (feet)	Depth to top of sample interval (feet)	Depth to bottom of sample interval (feet)	Water temperature (°C)	Specific conductance (µS/cm)
BFT-1810	1-28-87	12	202	175	202	21.5	1,540
	1-29-87			102	125	21	466
BFT-1814	1-13-87	12	202	175	220	21.5	816
	1-15-87			102	150	21.5	658
BFT-1841	2-03-87	120	190	96	100	20	3,500
HAM-122	06-25-85	75.0	174.00	82	174	20.5	285
	06-25-85					20.5	285
	05-21-86	--				20.5	290
JAS-136	06-26-85	20.0	245.00	200	245	21.5	200
	06-26-85					21.5	200
	05-22-86	--				21.5	209

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; μ g/L, micrograms per liter; gm/mL, grams per milliliter; ml, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Specific con- ductance, lab (μ S/cm)	Dissolved oxygen (mg/L)	pH (standard units)	pH, lab (standard units)	Dissolved residue 105 °C (mg/L)	Dissolved residue 180 °C (mg/L)
BFT-1810	1-28-87	1,520	0	7.39	7.02	--	854
	1-29-87	466	0	7.40	7.15	--	270
BFT-1814	1-13-87	835	0	7.8	7.67	--	474
	1-15-87	674	0	7.8	7.75	--	409
BFT-1841	2-03-87	3,380	0	7.4	7.18	--	1940
HAM-122	06-25-85	301	0	7.30	7.50	--	--
	06-25-85	--	0	--	7.78	132	--
	05-21-86	--	0.1	7.55	--	--	--
JAS-136	06-26-85	213	0	8.00	7.90	--	--
	06-26-85	--	0	8.00	8.11	101	--
	05-22-86	--	0.1	8.24	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Alkalinity, lab (mg/L as CaCO ₃)	Alkalinity, carbonate (mg/L as CaCO ₃)	Bicarbonate (mg/L as HCO ₃)	Density (gm/mL at 20 °C)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)
BFT-1810	1-28-87	163	168	205	--	.441	<0.010
	1-29-87	198	201	245	--	.365	<0.010
BFT-1814	1-13-87	148	143	174	--	--	<0.010
	1-15-87	157	158	193	--	--	<0.010
BFT-1841	2-03-87	132	133	162	--	.847	<0.010
HAM-122	06-25-85	--	149	181	0.998	0.016	<0.010
	06-25-85	155	149	181	--	--	--
	05-21-86	--	142	173	--	--	--
JAS-136	06-26-85	--	102	124	0.998	0.033	0.020
	06-26-85	101	102	124	--	--	--
	05-22-86	--	91	111	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nitrogen, NO ₂ +NO ₃ , dissolved (mg/L as N)	Phosphorous, dissolved, (mg/L)	Phosphorous, ortho, dissolved (mg/L as P)	Carbon, organic, total (mg/L)	Carbon, organic, dissolved (mg/L)	Sulfide, dissolved (mg/L)
BFT-1810	1-28-87	<0.010	0.010	0.020	-	2.1	--
	1-29-87	<0.010	0.030	0.050	--	2.9	--
BFT-1814	1-13-87	<0.100	0.040	0.020	--	2.2	--
	1-15-87	<0.100	0.030	0.020	--	3.1	--
BFT-1841	2-03-87	<0.010	0.010	0.020	--	2.3	--
HAM-122	06-25-85	<0.010	0.060	0.050	1.6	--	--
	06-25-85	--	--	--	--	--	0
	05-21-86	--	--	--	--	--	--
JAS-136	06-26-85	0.039	<0.010	<0.010	0.3	--	--
	06-26-85	--	--	--	--	--	0
	05-22-86	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
BFT-1810	1-28-87	130	28	110	4.4	350	7.7
	1-29-87	69	6.0	21	1.5	20	2.9
BFT-1814	1-13-87	43	10.7	110	3.9	140	59
	1-15-87	48	.4	77	3.6	90	30
BFT-1841	2-03-87	190	67	420	7.2	980	45
HAM-122	06-25-85	--	--	--	--	5.2	--
	06-25-85	50	5.1	5.6	1.9	3.3	3.3
	05-21-86	--	--	--	--	--	--
JAS-136	06-26-85	--	--	--	--	5.1	--
	06-26-85	13	11	9.2	2.3	4.3	6.7
	05-22-86	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; μ g/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Boron, dissolved (μ g/L)	Iron, dissolved (μ g/L)	Manganese, dissolved (μ g/L)	Molybdenum, dissolved (μ g/L)
BFT-1810	1-28-87	0.30	35	80	40	7	4
	1-29-87	0.30	36	40	73	29	4
BFT-1814	1-13-87	0.60	33	190	9	<1	5
	1-15-87	0.40	38	130	59	5	4
BFT-1841	2-03-87	0.20	34	110	300	50	600
HAM-122	06-25-85	--	27	<20	--	--	1
	06-25-85	0.10	19	--	570	52	--
	05-21-86	--	--	--	--	--	--
JAS-136	06-26-85	--	31	<20	--	--	3
	06-26-85	0.35	53	--	54	6	--
	05-22-86	--	--	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; μ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; μ g/L, micrograms per liter; gm/mL, grams per milliliter; ml, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Nickel, dissolved (μ g/L)	Strontium, dissolved (μ g/L)	Vanadium, dissolved (μ g/L)	Antimony, dissolved (μ g/L)	Aluminum, dissolved (μ g/L)	Lithium, dissolved (μ g/L)
BFT-1810	1-28-87	<1	1,800	<100	<1	<10	27
	1-29-87	<1	420	<8	<1	<10	17
BFT-1814	1-13-87	<1	450	<40	<1	<10	18
	1-15-87	<1	450	<30	<1	10	21
BFT-1841	2-03-87	60	1,000	<50	9	<10	20
HAM-122	06-25-85	2	--	<1	<1	10	10
	06-25-85	--	--	--	--	--	--
	05-21-86	--	170	--	--	--	--
JAS-136	06-26-85	1	--	<1	<1	10	10
	06-26-85	--	--	--	--	--	--
	05-22-86	--	410	--	--	--	--

Table 5.--Chemical and isotopic analyses of water samples from isolated sections of the upper permeable zone of the Upper Floridan aquifer in the vicinity of Port Royal Sound, S.C., 1984-87--Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, no data; T.U., tritium units; µg/L, micrograms per liter; gm/mL, grams per milliliter; mil, parts per thousand; <, less than]

Well number (figs. 1, 5)	Date	Tritium, Total (T.U.)	¹³ C/ ¹² C Stable isotope ratio (per mil)	² H/H Stable isotope ratio (per mil)	¹⁸ O/ ¹⁶ O Stable isotope ratio (per mil)	¹⁴ C (Percent Modern)
BFT-1810	1-28-87	--	-8.40	--	--	18.9
	1-29-87	--	-10.40	--	--	25.5
BFT-1814	1-13-87	--	-7.50	--	--	12.8
	1-15-87	--	-9.30	--	--	15.4
BFT-1841	2-03-87	--	-12.70	-19.0	-3.40	27.0
HAM-122	06-25-85	--	-10.50	-16.0	-3.41	37.2
	06-25-85	--	--	--	--	--
	05-21-86	--	--	--	--	--
JAS-136	06-26-85	--	-3.00	-16.8	-3.62	<1.5
	06-26-85	--	--	--	--	--
	05-22-86	--	--	--	--	--